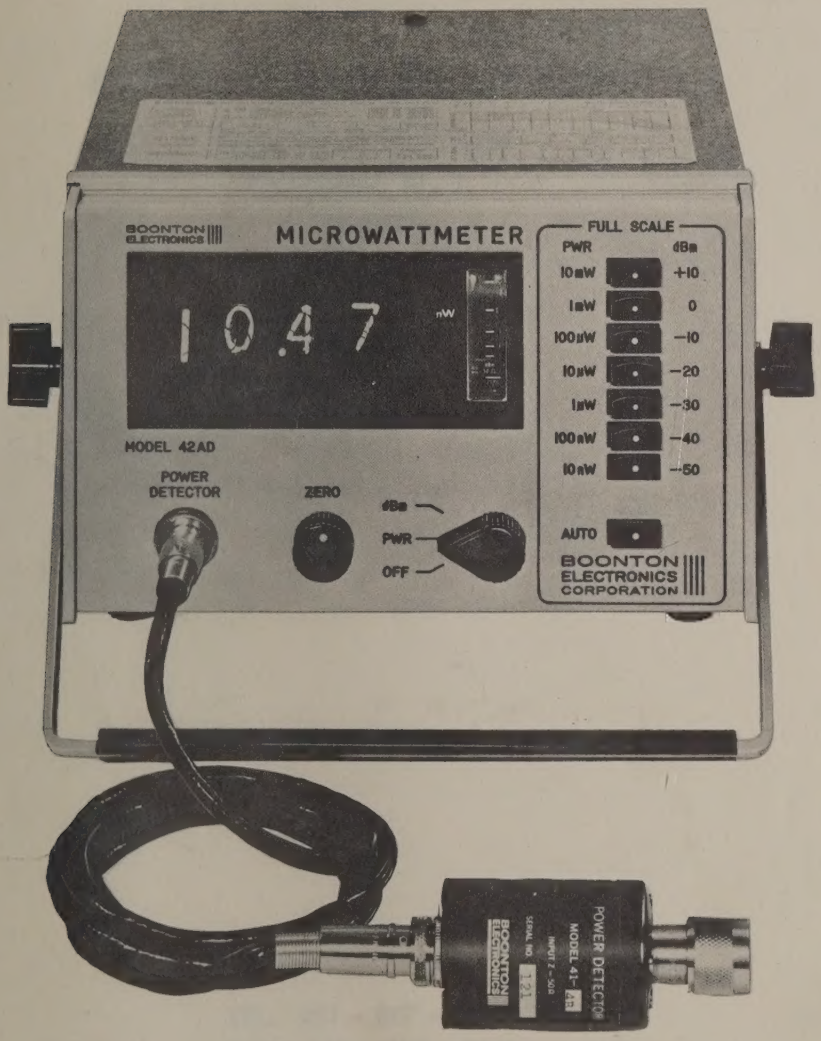
RF MICROWATTMETER

MODEL 42AD



INSTRUCTION MANUAL

MP MASTER
MA24767
42AD
b-171

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TABLE OF CONTENTS

CHAPTER		PAGE
I	INTRODUCTION	
	1.1 GENERAL	1
	1.2 EQUIPMENT DESCRIPTION	2
	1.2.1 Frequency Range	2
	1.2.2 Power Range	3
	1.2.3 Response	3
	1.2.4 Noise	3
	1.2.5 Zero Adjustment	3
	1.2.6 Analog Output	3
	1.2.7 BCD Output	4
II	SPECIFICATIONS	6
III	OPERATION	10
	3.1 INSTALLATION	10
	3.1.1 Controls and Indicators	10
	3.2 OPERATING PROCEDURE	11
	3.2.1 Initial Operating Procedure	11
	3.2.2 Connection Recommendations	12
	3.2.3 Low Level Measurements	12
	3.2.4 High Level Measurements	12
	3.2.5 High Frequency Measurements	13
	3.2.6 Temperature Effects	13
	3.2.7 VSWR Measurements	13
	3.2.8 Zero Adjustment Precautions	13
	3.2.9 Over/Under Range Indication	14
	3.2.10 Analog Output	14
	3.2.11 BCD Output	14
	3.2.12 Autoranging Option	15
	3.2.13 Logic-Level Programming Option	15
	3.2.14 dBm/Power Readout Option	15
IV	THEORY OF OPERATION	16
	4.1 GENERAL	16
	4.1.1 Power Detector	17
	4.1.2 Chopper and Chopper Driver	17
	4.1.3 Attenuator and Amplifiers	17
	4.1.4 Synchronous Detector	17
	4.1.5 Shaping Amplifier	18
	4.1.6 Digital Control	18
	4.1.7 Analog-Digital Converter	18
	4.1.8 Power Supply	18
	4.1.9 Programming	18

CHAPTER		PAGE
V	MAINTENANCE	20
	5.1 PERIODIC CALIBRATION	20
	5.2 CALIBRATION PRECAUTIONS	20
	5.3 CALIBRATION CHECK	20
	5.4 CALIBRATION PROCEDURE	20
	5.5 TROUBLE-SHOOTING	22
	5.5.1 Cover Removal	22
	5.5.2 Chopper Replacement	22
	5.5.3 Voltage and Resistance Tests	23
	5.5.4 Power Detector Replacement	23

LIST OF ILLUSTRATIONS

FIGURE NO.		PAGE
1	Accuracy and VSWR Specifications	5
2	Detector Temperature Characteristic	9
3	System Temperature Characteristic	9
4	Block Diagram, 42AD	16
5	External Connections	24
6	Calibration Outline	27

TABLES

TABLE NO.		PAGE
1	Controls and Indicators	10
2	External Connections	25
TABLE OF REPLACEABLE PARTS - 42AD		PL 1
	42AD-01	PL 15
	42AD-02	PL 18
	42AD-09	PL 19
SCHEMATICS		ENDFOLD

CHAPTER I

INTRODUCTION

1.1 GENERAL

The Model 42AD Microwattmeter is the digital version of the Model 42A series. These instruments provide a sensitive, accurate means of measuring small amounts of high-frequency power from one nanowatt to ten milliwatts (-60 to +10 dBm) over a frequency range of 200 kHz to 12.4 GHz. The detection system does not employ thermal elements, avoiding many of the difficulties inherent in that method of sensing, and permitting the detector head to be located at fairly long distance from the instrument. The detector does not require balancing, and is relatively insensitive to changes in ambient temperature.

A completely solid-state design, the 42AD possesses a high degree of sensitivity and stability, low noise level, and low input VSWR. Drift is not a problem, and large temporary overloads do no permanent harm to the instrument or the detector.

A linear dc output and a BCD output are provided at terminals on the rear panel. The linear dc voltage, directly proportional to the input power, may be used to drive a recorder, to connect to an oscilloscope for swept-frequency scans, or for interfacing with an external system. The BCD output, using standard positive logic and TTL-compatible, may be used to interface with computer-controlled test systems, printers, or comparators.

Solid-state switching is used for range and mode selection; this feature makes it simple to program and control the instrument remotely or from an external automatic system.

A small edgewise panel meter, calibrated in dBm, is standard on the 42AD. While intended for use in zeroing the instrument on the lower ranges, this meter may be used for making comparative dBm measurements with acceptable accuracy. Direct digital readout of power in terms of dBm at the full accuracy of the instrument is available as an option. Other options currently available are Logic-Level Programming and Autoranging.

The 42AD offers itself as an accurate and convenient means of making a variety of measurements. Representative uses of the instrument include:

Adjustment of low-power microwave transmitters and sub-systems.

VSWR and return-loss measurements with directional couplers and slotted lines.

Gain and loss measurements of rf amplifiers.

VSWR and attenuation of rf attenuators.

Microwave antenna adjustments.

The Model 42AD is available in several optional configurations. Standard features of all models include:

Remote programmability

DC analog output

BCD output

Low VSWR

Convenient push-button ranging

Overload protection to 300 milliwatts

Range of one nanowatt to ten milliwatts

The basic characteristics of the instrument include high reliability, fast warm-up, long intervals between calibrations, plug-in printed-circuit boards for ease in servicing or modification, light weight, low power consumption, and other advantages of solid-state design.

1.2 EQUIPMENT DESCRIPTION

The Model 42AD actually measures the rf voltage appearing across an accurate, non-inductive resistance element in the Power Detector. The digital indicator, of course, is calibrated in terms of power in accordance with the relationship $P = E^2/R$.

The instrument is available with a range of options and Power Detectors, listed and described in Chapter II. In all options, input range programming can be controlled by external contact closures or PNP transistors to ground. It is sensitive, accurate, sturdily built and well protected against accidental overload. Performance over long periods of time without failure or need for recalibration is standard.

The Model 42AD is packaged as a compact bench instrument. Should rack mounting be desired, both single-unit and double-unit rack-mounting kits are available to hold one or two instruments.

Important accuracy and VSWR information is reproduced on a reference plate attached to the outside top cover of the instrument. Calibration instructions are reproduced on the underside of the top cover.

The Model 42AD is normally ordered with one of the following Power Detectors:

Model 41-4A	200 kHz to 7 GHz
Model 41-4B	200 kHz to 12.5 GHz
Model 41-4C	200 kHz to 1 GHz (75Ω)

1.2.1 Frequency Range

The calibrated frequency range of the instrument extends from 200 kHz to 12.4 GHz, depending upon the particular Power Detector being used. Useful response for

relative measurements can be obtained from 20 kHz to beyond 14 GHz. See Figure 1 for accuracy and VSWR charts.

The 75Ω Power Detector (Model 41-4C) is intended primarily for use in the CATV industry.

1.2.2 Power Range

With any of the Power Detectors, the Model 42AD will measure powers from one nanowatt up to ten milliwatts. Temporary overloads of as much as 300 milliwatts will do no permanent harm to the instrument or to the Power Detector. When measuring pulsed signals, accuracy is good up to 30 microwatts peak power (15 microwatts average power). The power capabilities of the 42AD can be increased by the use of suitably designed attenuators.

1.2.3 Response

At low power levels the detector diodes operate in the square-law region; instrument response is to the average power level. Above the transition level (approximately ten microwatts) the response tends towards the peak value, although the digital indicator is calibrated in terms of average power.

1.2.4 Noise

The Model 42AD has been designed and built to hold noise from all sources to a minimum.

The Power Detector cable is of special low-noise design; a vigorous flexing causes only momentary, minor fluctuations on the most sensitive range of the instrument. The Power Detectors are not sensitive to shock or vibration; even sharp tapping on the Detector barrel will cause no change in the reading.

All amplification is done at a frequency of 94 Hz, reducing any susceptibility to 50 or 60 Herz power-line fields. A unique circuit reduces the low-level noise originating in the mechanical chopper and renders the instrument immune to changes in chopper performance that could occur with the passage of time.

1.2.5 Zero Adjustment

Zero adjustment is not normally required on the upper ranges of the Model 42AD. When measurements are to be made on the lower ranges, the ZERO control is easily adjusted on the most sensitive range before commencing operation. This control balances out small thermal voltages in the sensing elements and, once set, needs only infrequent checking during the course of subsequent measurements.

1.2.6 Analog Output

The 42AD provides a dc output voltage which is directly proportional to the input

power being measured. The current capacity of 1 mA into 1000 ohms is extremely stable; the maximum voltage at full scale is 10 volts. When the instrument is used as a part of an automatic test system, the fast response of the dc output to an input step function allows more tests per unit time.

1.2.7 BCD Output

The Model 42AD provides a binary-coded-decimal output (4-line, 8, 4, 2, 1) for connection to an external system. When the instrument forms an integral part of a system configuration, it may be remotely controlled and triggered manually, or automatically in synchronism with some system event.

For system or external requirements, all input and output connections are made at the card-edge connector on the rear of the instrument case. See Figure 5 and Table 2 for receptacle connections and signal identification.

POWER DETECTORS AND FREQUENCY RANGES

MODEL 41-4B: 50Ω, 0.2MHz TO 12.4GHz
MODEL 41-4A: 50Ω, 0.2MHz TO 7 GHz
MODEL 41-4C: 75Ω, 0.2MHz TO 1 GHz

ACCURACY

	0.1μW TO 10mW RANGES			10nW RANGE		
	± ONE DIGIT, ±			± TEN DIGITS, ±		
	0.2dB	0.3dB	0.4dB	0.4dB	0.5dB	0.6dB
WITH 41-4B DET:	0.2MHz 4GHz 8.2GHz 12.4GHz			0.2MHz 4GHz 8.2GHz 12.4GHz		
WITH 41-4A DET:	0.2MHz 4GHz 7GHz			0.2MHz 4GHz 7GHz		

OPERATION

WARM-UP PERIOD 1 MIN.; ADJUST ZERO ON 10nW RANGE WHEN MEASURING BELOW 1μW (-30dBm).

TEMPERATURE INFLUENCES

TEMPERATURE RANGE	INSTRUMENT	DETECTOR
REFERENCE 21°C TO 25°C	0	0
NORMAL 18°C TO 30°C	0	±0.1dB
SEVERE 10°C TO 40°C	±0.2 dB	±0.2 dB

DIGITAL dBm ACCURACY; MODEL 42AD-09 ONLY

	0.1 dB, PLUS		
−40dBm TO +10dBm RANGES	±0.2dB	±0.3dB	±0.4 dB

WITH 41-4B DET: 0.2MHz 4GHz 8.2GHz 12.4GHz
WITH 41-4A DET: 0.2MHz 4GHz 7GHz

	0.2 dB, PLUS		
−50dBm RANGE	±0.4 dB	±0.5dB	±0.6 dB

WITH 41-4B DET: 0.2MHz 4GHz 8.2GHz 12.4GHz
WITH 41-4A DET: 0.2MHz 4GHz 7GHz

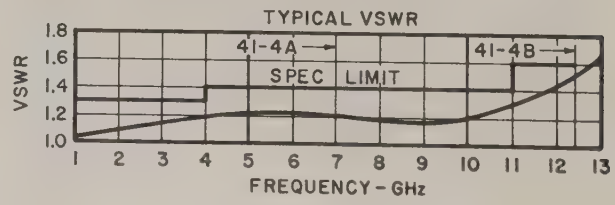


Figure 1. Accuracy and VSWR Specifications

CHAPTER II

SPECIFICATIONS

Power Range: One nW (-60 dBm) to 10 mW (+10 dBm) in seven decade ranges.

Full Scale Power Ranges: 10 nW, 100 nW, 1 μW, 10 μW, 1 mW, 10 mW.

Full Scale dBm Ranges: -50, -40, -30, -20, -10, 0, +10

Frequency Range:
0.2 MHz to 12.4 GHz with 41-4B Detector
0.2 MHz to 7 GHz with 41-4A Detector
0.2 MHz to 1 GHz with 41-4C Detector (75Ω)

Accuracy:

10 nW to 10 mW (-40 to +10 dBm)

	± One digit, plus		
	± 0.2 dB	±0.3 dB	± 0.4 dB

With 41-4B	0.2 MHz	4 GHz	8.2 GHz	12.4 GHz
With 41-4A	0.2 MHz	4 GHz	7.0	
With 41-4C	0.2 MHz	1 GHz		

1 nW to 10 nW (-6 to -50 dBm)

	± Ten digits, plus		
	± 0.4 dB	±0.5 dB	± 0.6 dB

With 41-4B	0.2 MHz	4 GHz	8.2 GHz	12.4 GHz
With 41-4A	0.2 MHz	4 GHz	7.0 GHz	
With 41-4C	0.2 MHz	1 GHz		

Indicator: Digital Nixie-type display; 3 digits plus 1, decimal point, units (dBm, nW, μW, mW), under-range, over-range, and + or - (dBm only).

Meter: Miniature edgewise type; calibrated -9 to +3 dBm.

RFI: There is no detectable radiated or conducted leakage from the instrument or the Power Detector.

Temperature: In accordance with ANSI (ASA) Spec. 39.7

Temperature Range	Influence	
	42AD	Detector
Ref. 21°C - 25°C	0	0
Normal, 18°C - 30°C	0	±0.1 dB
Severe, 10°C - 40°C	±0.2 dB	±0.2 dB

Waveform Response: Input level 1 nW to 10 μW: True average power

Input level above 10 μW: Average power of sine wave (true rms response changing to peak response)

Power Detectors: Input connection: Type N Precision
Output connector to fit 41-2A cable.
Dimensions: 1.5" (38mm) diameter
3.5" (90mm) length

	Model 41-4A	Model 41-4B	Model 41-4C 41-4C
Input Impedance	50Ω	50Ω	75Ω
Freq. Range	0.2 GHz - 7 GHz	0.2 MHz - 12.4 GHz	0.2 MHz - 1 GHz
VSWR	1.3 to 4 GHz 1.4 to 7 GHz	1.3 to 4 GHz 1.4 to 11 GHz 1.6 to 12.4 GHz	1.3 to 1 GHz

(Calibration curves furnished with detectors)

BCD Output: 4-line (8, 4, 2, 1) where logic 1 is 4 volts and logic 0 is 0.4 volts.

Analog Output: 0 to 10 volts dc, directly proportional to the rf input power. Source resistance of 9 kΩ, delivering 1 mA max. into 1000Ω load.

	Response time to full-scale step function: 10 μW (-20 dBm) to 10 mW (+10 dBm) fs: 100 ms. max. Below 10 μW to 10 nW (-50 dBm) fs: 1 sec. max.
Programming:	Input range controllable by external contact closures or PNP transistors to ground.
Dimensions:	6.0" (152 mm) high, 8.3" (211 mm) wide, 12.0" (305 mm) deep.
Weight:	9.75 lbs. with cable and Detector.
Equipment Options:	Model 42AD-01: Autoranging option. Digits, decimal points and units are automatically displayed. Allows programmable and manual selection of autorange. Model 42AD-02: Logic-level programming option. 8-line logic-level input selects range. Additional logic-level lines select dBm or autorange if optioned. TTL compatible. Model 42AD-08: Rear signal-input option; a separate jack for the detector cable connector is mounted on the rear panel. Model 42AD-09: dBm/power readout option. Allows manual and programmable selection of either dBm or power to be read on the digital display. Logic-level outputs indicate power and ±dBm.
Accessories supplied:	5-foot power detector cable Model 41-2A.
Power Requirements:	115/230 V AC, 50/400 Hz, 20 W

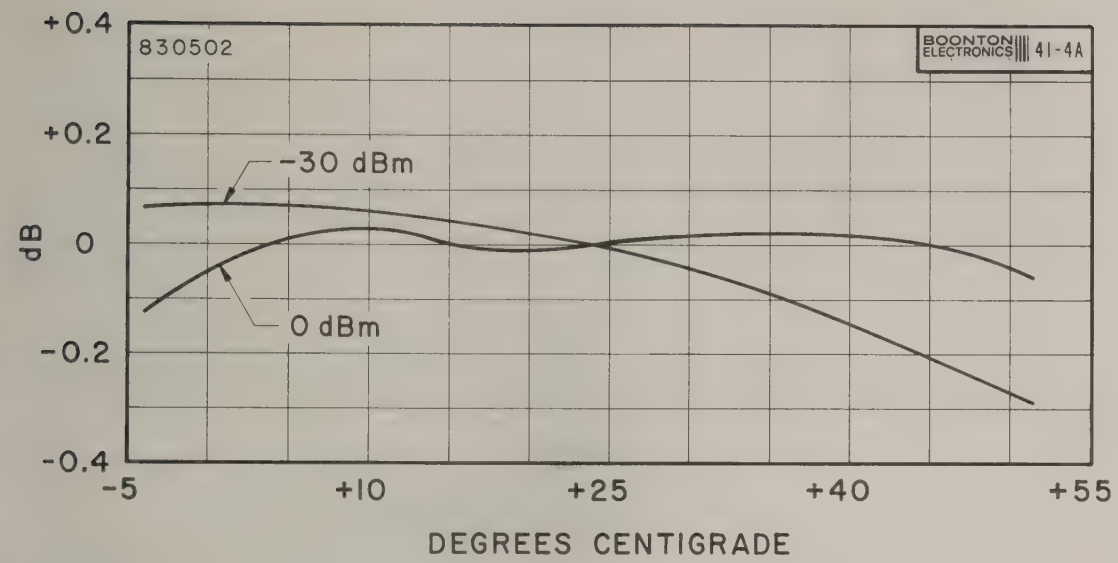


Figure 2. Detector Temperature Characteristic

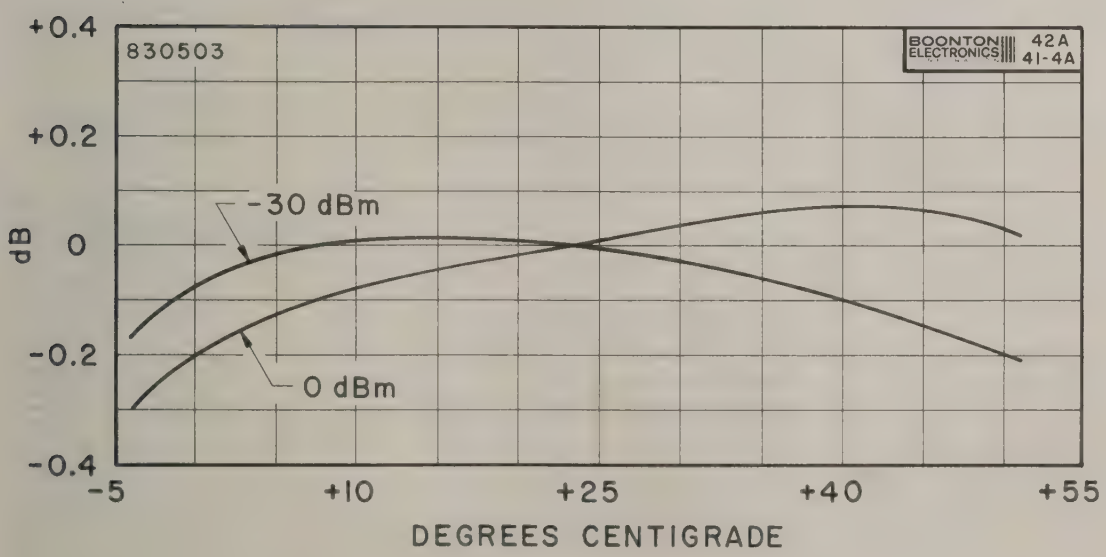


Figure 3. System Temperature Characteristic

CHAPTER III

OPERATION

3.1 INSTALLATION

Each instrument has been inspected and tested at the factory for compliance with all specifications before packing. Should any indication of shipping damage appear when unpacking, be sure to notify the carrier immediately. It is recommended that all the packing material be saved for use in the event the instrument must be reshipped in the future.

3.1.1 Operating Controls and Indicators

The controls and indicators of the 42AD are described in Table 1 below:

Table 1

Model 42AD Controls & Indicators

ITEM	FUNCTION
PWR Switch	This switch controls the primary power to the instrument; when the dBm option is installed, the dBm position of the switch changes the indicator to read + or - dBm.
FULL SCALE Buttons	These range selector push-buttons switches select the operating range of the 42AD. The AUTO push-button engages the autoranging circuits when this option has been installed.
Indicator	Nixie-type readout, showing 3 digits plus one, polarity (dBm), units (nW, μW, mW, or dBm), over- and under-range indicators.
POWER DETECTOR Jack	The Power Detector cable is connected to the instrument through this jack. Always be sure that the knurled nut of the cable connector is firmly tightened.
ZERO	This control is used to set the instrument to zero on the lower ranges.
Panel Meter	This small edgewise meter, calibrated in dBm from -10 to +3, is used in conjunction with the ZERO control to zero the instrument. It is not

Panel Meter (cont'd.)	possible to zero using the digital indicator, as it automatically blanks out at 10% under the lower limit of the range in use.

The following items are on the rear panel:

Fuse Holder and Fuse	For either a 0.1 ampere, 115 volt, or a 0.06 ampere, 230 volt, Bussman MDL SLO-BLO fuse.
Slide Switch	This switches the power transformer primary to 115 or 230 volts, according to the available power source. (Be sure that the proper fuse for the line voltage used is in the fuse holder)
Recorder Output	A dc voltage proportional to the input power level is available at these terminals. Full-scale output is +10 volts; output resistance is 9000 ohms.
Remote Connections	A card-edge connector is mounted at the rear of the instrument for remote control and BCD outputs. Connection should be made with an Amphenol 225-2221-101 connector or equivalent.
(Symbol on Rear Panel)	This safety requirement has been adopted by the International Electrotechnical Commission, Document 66 (Central Office) 3, Paragraph 5.3, which directs that an instrument be so labelled if, for the correct use of the instrument, it is necessary to refer to the instruction manual. In this case it is recommended that reference be made to the instruction manual when connecting the instrument to the proper power source.

3.2 OPERATING PROCEDURE

Although the operation of the 42AD is simple and largely selfevident, it is recommended that the paragraphs following be read before the instrument is put into operation.

3.2.1. Initial Operating Procedure

a. Each instrument is calibrated at the factory with its matching Power Detector, which bears the same serial number. Be sure that that the two numbers agree, as if another Detector is used with the instrument an error may be introduced.

b. Connect the Power Detector to the cable, and the cable connector to the POWER DETECTOR jack on the front panel. Both connectors should be firmly tightened.

c. Check the setting of the slide switch on the rear panel and the powerline fuse for the available powerline voltage, and plug the instrument's power cable into an outlet.

d. Turn the front-panel power switch to PWR and allow the instrument to warm up for a minute or so.

e. Press the 10 nW range button. The needle of the panel meter should rest somewhere near the zero reference mark at the bottom of the scale. With no signal into the Detector, adjust the ZERO control knob to set the pointer to the zero reference.
Because of the instrument's sensitivity on this range, some indicator fluctuation will be noted. Proper zero setting is reached when the pointer fluctuates evenly around the reference line. If the Detector is in a strong power-line or noise field, zeroing can be difficult. See paragraph 3.2.7 for shielding suggestions.

While the Power Detector is relatively immune to temperature effects, zeroing will be simpler if the Detector has reached thermal equilibrium first.

3.2.2 Connection Recommendations

All Power Detectors are equipped with a precision Type N coaxial connector for connection to the power source under study.

Although the Power Detectors are carefully insulated against variations in ambient temperature, it is advisable to locate the Detector away from any sources of heat when using the most sensitive ranges. For example, if measuring the output of equipment which generates significant quantities of heat, the Power Detector should be connected to the device via a sufficient length of coaxial cable to allow good air circulation around the Detector. If this cannot be done, then allow sufficient time for the total assembly to reach thermal equilibrium before making any measurements.

3.2.3 Low Level Measurements

The Model 42AD will provide reliable, reproducible measurements of cw power levels as low as one nanowatt (-60 dBm). It can also be used, although with slightly decreased accuracy ($\pm$1 dB) for pulse measurements. The peak power, when measuring pulsed power, should not exceed 30 μW (-18 dBm). Above these levels, the detector enters the region where it functions as a peak detector; accuracy, except for cw measurements, cannot be guaranteed under these conditions.

When using the three most sensitive ranges (10 nW, 100 nW, and 1 μW), the preliminary zero zero adjustment is required. This is described in Par. 3.2.1.

3.2.4 High Level Measurements

When using the higher ranges of the 42AD (10 μW to 10 mW) it is not necessary to make the zero adjustment. The same limitation on allowable peak power for pulse measurements applies. It is suggested that higher powers be measured through an attenuator rather than directly.

3.2.5 High Frequency Measurements

For the specified accuracy above 1 GHz, the correction chart on the barrel of the Power Detector must be used. The correction factor given should be added algebraically to the indicated reading. For example, if the meter reads -22.2 dBm at 3 GHz and the correction from the chart at 3 GHz is +0.2 dBm, the corrected value is -21.9 dBm.

NOTE

The Model 41-4A and 41-4B Power Detectors are calibrated for use with a 50 ohm source. Large deviations from 50 ohms may cause serious errors from the mismatch and the resultant increased VSWR. This effect can be reduced by inserting a low-VSWR attenuator (VSWR < 1.10) between the source and the detector; alternatively, a low-pass tuner may be inserted at this point.

The Model 41-4C Power Detector is calibrated for use with a 75 ohm source. The same comments apply in this case.

3.2.6 Temperature Effects

The accuracy specifications for the Model 42AD apply over an ambient temperature range of 60°F to 90°F (16°C to 32°C). Operation outside this temperature range is possible, but some inaccuracy can be expected. Figure 2 shows a typical temperature characteristic of a Power Detector, and Figure 3 shows the temperature characteristic of the Model 42AD and a Power Detector together.

NOTE

For the best zero stability, the Power Detector and the instrument should be allowed to reach ambient temperature.

3.2.7 VSWR Measurements

The high upper-frequency limits and the sensitivity of the Model 42AD make it a useful instrument for measuring VSWR in conjunction with a slotted line. As this type of measurement requires only comparative values, rather than absolute values, the 42AD may be used above its calibrated range - as high as 14 GHz.

VSWR is determined by measuring the dB difference between a maximum and a minimum power point on a slotted line, then converting this power difference to VSWR. An adapter is needed to couple the detector to the slotted line; these are usually available from the manufacturer of the slotted line used.

3.2.8 Zero Adjustment Precautions

The zero adjustment is required when making measurements on the three lowest

ranges of the 42AD, and also when setting the instrument up for the first time. (Par. 3.2.1) If strong noise fields are present, it may be difficult to zero the instrument unless the Power Detector is shielded from these fields.

The easiest means of shielding the detector is to connect it to the device being used for measurements, making sure that the device is turned off. Should the device itself act as an antenna to introduce additional noise signals, it is recommended that a shielded termination for the detector be made up from a Type N coaxial jack and some thin copper sheet.

3.2.9 Over/Under Range Indication

When the power applied to the detector is 5% above the maximum of the range in use, or 10% below the minimum, the display will blank out and an upward or downward pointing arrow symbol will appear. Switch to the next higher or lower range, as appropriate.

If the instrument is a Model 42AD-01 (Auto Ranging), the range is automatically switched when the applied power approaches the range limits (if the AUTO button switch has been depressed).

3.2.10 Analog Output

The dc output voltage at the RECORDER terminals on the rear panel of the instrument is directly proportional to the power level at the Power Detector. It is positive with respect to the chassis, with a maximum value of 10 volts at full scale.

The voltage is linear with respect to power down to about 10% of full scale (the point where the digital display blanks out). Linearity is not good below this point, and the operator should switch the instrument's range to the next lower scale. Terminal 17 on the card-edge connector at the rear is at Logic 1 (about +4V) when the instrument is measuring a value within its chosen range, and goes to Logic 0 (about +0.4V) when the value goes below range and the indicator blanks. Connection 18 operates in similar fashion for over-range indication. If desired, these outputs could be used to operate an external warning device to alert the operator at these points that the dc output has entered the unreliable range.

3.2.11 BCD Output

Binary-coded decimal (BCD) outputs are available at the card-edge connector. These are 4-line, (8, 4, 2, 1), where Logic 1 $=\geq$ 3V and Logic 0 $=\leq$ 0.3V (positive). Additional BCD data include over- or under-range indication, operation mode, and polarity.

Commands are also applied at the card-edge connector. These include encode hold, encode trigger, manual disable, auto enable (for the -01 option) and dBm enable (for the -09 option).

3.2.12 Autoranging Option (42AD-01)

The instrument can be operated in the automatic ranging mode by pressing the AUTO switch on the panel, or by grounding the appropriate pin on the card-edge connector. With this option, the range is automatically switched up or down as the applied power approaches triggering points slightly above or below the calibrated range. These triggering points are carefully adjusted at the factory to insure that there is adequate overlap between adjacent ranges. NOTE: The 42AD must be zeroed before using autorange.

When the 42AD-01 forms part of an external system, application of a Logic 0 ($\leq$ 0.3V) to the pin will switch the instrument to autorange. In either case, the range in use is immediately apparent by the position of the decimal point and by the power mode indicator (nW, μW, or mW).

3.2.13 Logic-Level Programming Option (42AD-02)

When used as a component of a computer-controlled test system, the ranging and modes are selected by standard 8-line logic-level inputs to the card-edge connector. In all cases, Logic 0 switches on and Logic 1 switches off.

If options -01 or -09 are used, logic-level inputs also control these operations.

3.2.14 dBm/Power Readout Option (42AD-09)

With this option, the readout can be switched to indicate either power or dBm. Switching can be manual, on the front panel or remotely, or by logic-level inputs when using the 42AD-02 option. Logic-level outputs indicate power and + or - dBm.

CHAPTER IV

THEORY OF OPERATION

4.1 GENERAL

The block diagrams shown below illustrates the essential portions of the 42AD. Detailed schematic diagrams of the several sections of the basic instrument, and of the options available, will be found at the back of this manual. Brief discussions of the operations of the various sections are on the pages following.

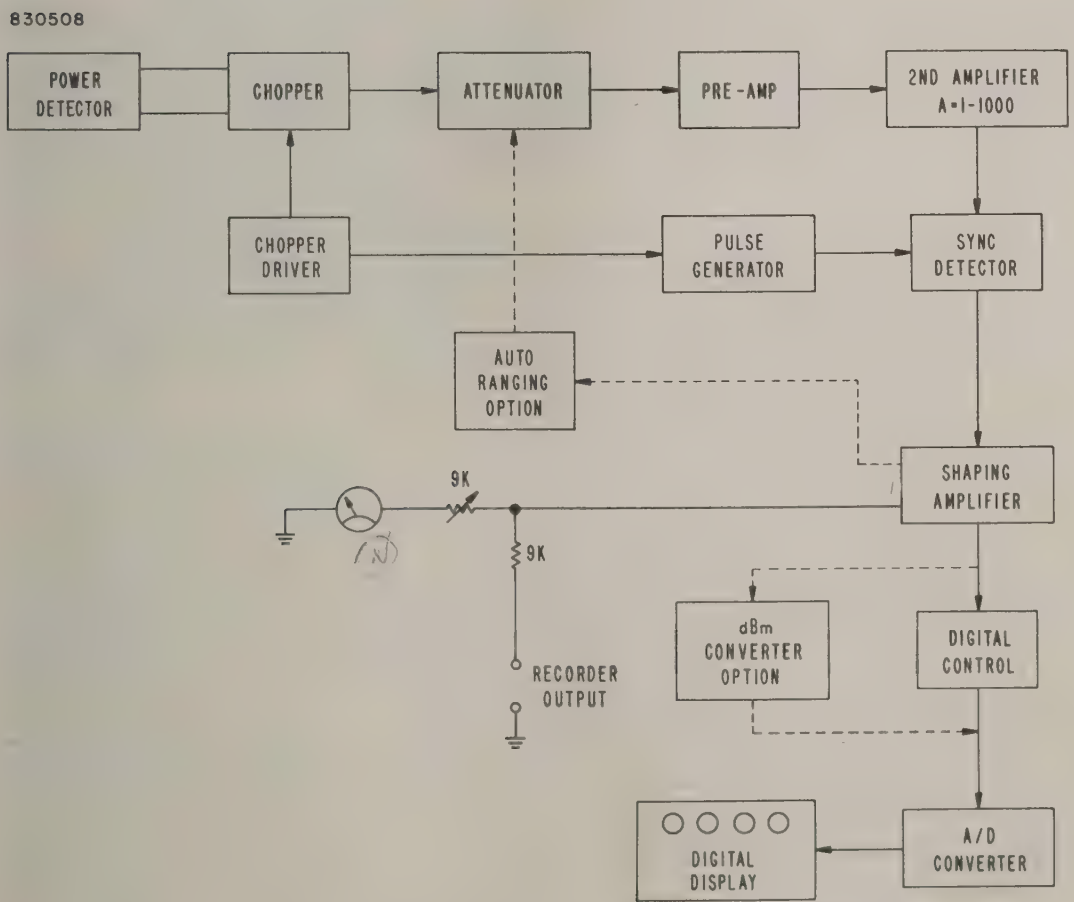


Figure 4. Block Diagram, 42AD

4.1.1 Power Detector

The power detector contains a non-inductive load resistor of 50 ohms (75 ohms in the 41-4C) and a pair of selected diodes connected as a full-wave rectifier across the resistor. The rf voltage appearing across the resistor is rectified by the diodes, producing a dc voltage whose level is a function of the power applied. When the applied power is within the square-law region of the diodes (approximately 15 microwatts) the detector produces true rms response. Above this power level the response approaches peak-to-peak, calibrated on the indicator in terms of rms power. The use of full-wave rectification permits the measurement of highly asymmetrical waveforms without substantial error.

The body of the detector is very carefully designed and fabricated to eliminate any cavity resonance effects within the calibrated frequency range. The special diodes are selected for this application; in general, they should not be replaced with off-the-shelf types by the user in cases of accidental burnout.

4.1.2 Chopper and Chopper Driver

The dc voltage from the power detector is changed to ac by means of a mechanical chopper, driven by the chopper driver circuits. The chopper driver frequency is obtained by dividing the output of a unijunction oscillator by two. This oscillator also generates the switching pulse for the synchronous detector; diode gating feeds the pulse from the pulse generator to the proper JFET, depending on chopper phase.

4.1.3 Attenuator and Amplifiers

The ac voltage from the chopper is applied to the attenuator and amplifier sections. The pre-amplifier, with a constant gain of X1000, is designed for very low noise. The second amplifier is designed to show an output of 3 volts peak-to-peak at full scale for each range; this is done by ranging both the attenuation and the gain of the second amplifier.

Both amplifiers are stabilized by large amounts of inverse feedback and exhibit moderately wide bandwidths.

4.1.4 Synchronous Detector

The amplified signal from the second amplifier is converted to dc in the synchronous detector; this is driven by pulses triggered by the chopper driver circuit, assuring accurate synchronization. The peak-to-peak amplitude is derived from a shunt-series capacitor storage circuit using JFET switches.

The characteristics of the detector determine the effective bandwidth of the amplifier-detector combination and allow modification of the bandwidth for different range conditions. The detector also provides conversion without offset, with excellent linearity.

4.1.5 Shaping Amplifier

The conversion of rf to dc in the power detector is non-linear, the response being virtually square-law for for the lowest ranges and gradually becoming quasi-linear for the 10 mW range. The shaping amplifier converts the non-linear output of the detector to a linear output by using a segmental approximation to the exact correction. The shaping amplifier is an operational amplifier connected so that, as the signal increases at its output, its gain is reduced by successively paralleling resistors across the feedback resistors. The number of segments needed adequately to linearize the response varies from 6 for the "square-law" ranges down to 3 for the 10 mW range. The output of the shaping amplifier at full scale is +10 volts; this voltage is applied to the miniature panel meter, to the RECORDER terminals through a 9 kΩ resistor, and to the digital control circuits.

4.1.6 Digital Control

The analog dc signal voltage from the Shaping Amplifier is processed by the digital control circuits before being passed on to the Analog-Digital Converter and the Digital Display unit. The Digital Control section divides the incoming voltage (10 volts full scale) by a factor of 10 or 31, depending upon which range group has been selected. It extracts information for the control of range, decimal point position, over- or under-range indications, polarity indication and mode indication. (On the 42AD-09 option, this section also contains the additional circuitry to convert the incoming power information to dBm values) The processed analog signal is then passed on to the Analog-Digital Converter section.

4.1.7 Analog-Digital Converter

This is a dual-slope type of converter. Incoming analog information is converted to digital form and applied to the Digital Display Unit, where the appropriate elements of the Nixie-type display tubes are triggered. These show not only numerals, but also decimal point, over- and under-range indicators, polarity, and mode identification (nW, μW, mW, dBm).

4.1.8 Power Supply

The power supply section converts the ac line power input to regulated +16 and -15 volts for equipment. Current limiting is used to protect both supplies against accidental short circuit damage.

The +16 volt supply is a zener-biased follower, and no adjustment of the output voltage is provided. The -15 volt supply, which is referred to a 6.2 volt zener, is adjustable to -14.9, +0.1 volts.

4.1.9 Programming

The 42AD is organized around an eight-line ranging system. In each functional subcircuit, switching is done with solid-state devices (JFETs) which are actuated by grounding the appropriate range line. The panel range switches are connected to the

range lines, which are also extended to the rear of the instrument for remote ranging. External connections are made to the card-edge connector on the rear panel; remote ranging is done by grounding the 'manual disable' line and then the appropriate range line.

Connection to the card-edge connector should be made by an Amphenol 225-2221-101 connector, or equivalent.

CHAPTER V

MAINTENANCE

5.1 PERIODIC CALIBRATION

The Model 42AD is designed to provide trouble-free operation over extended periods of time. However, as with any precision instrument, it should be checked periodically to verify its calibration. To make a calibration check, the following equipment is needed:

a. A reliable signal source of 200 kHz to 500 kHz with less than 1% distortion at levels up to 3 volts across 50 ohms.

b. A precision voltmeter such as the Balantine Model 310A or 314, or the Hewlett-Packard Models 400D, 400H, or equivalent.

c. A precision dc voltmeter capable of measuring -15.0V and -3.0V with an accuracy of ±0.25%.

5.2 CALIBRATION PRECAUTIONS

The accuracy of the ac monitoring meter should be verified, using a low-frequency (50-100 Hz) source of good waveform, and a dynamometer type of ac meter of at least 1% accuracy.

When checking an instrument having the sensitivity and bandwidth of the 42AD, it is essential to take precautions against errors resulting from stray pick-up. A well-shielded signal source must be used with coaxial connections to both the 42AD and the standard reference meter. Even with a well-shielded generator and connections, it is sometimes possible for the reference meter to pick up stray rf signals and feed them into the power detection head. It is advisable to test for this condition by disconnecting the standard meter and noting any change in level.

5.3 CALIBRATION CHECK

Using the signal source and ac voltmeter from the list above, check the calibration of the 42AD on each range, applying a voltage input equal to the full-scale reading value. If this check shows that the instrument is out of calibration, follow the procedure in Paragraph 5.4 to recalibrate it.

5.4 CALIBRATION PROCEDURE

The Model 42AD should be calibrated at room temperature (approximately 74°F) after a minimum warm-up time of one minute.

The Calibration Outline shown in Figure 6 is also printed inside the top cover of the instrument. This outline lists, in abbreviated form, the steps described in the procedure following:

Adjustment No. 1. Measure the -15.0V dc voltage at Test Point No. 5, located on the main amplifier board to the left of R145. Adjust R145 for a reading of -14.9 volts, ±0.1 volt.

Adjustment No. 2. Measure the +15.0 volts dc at Test Point 2 on the Shaping Amplifier board. Adjust R571 for a value of +15.0 volts, +0.1 volt.

Adjustment No. 3. Set instrument to the 10 nW range, and adjust the panel ZERO control for a zero-reference reading on the miniature panel meter.

Adjustment No. 4 Switch to the 10 μW range and adjust R233 for a reading of zero on the panel meter.

Adjustment No. 5** Switch to the 1 μW range, apply 7.071 ±0.2% mV to the detector, and adjust R151 for a reading of -3.0Vdc ±1% at Test Point 1 on the Shaping Amplifier board. *

Adjustment No. 6 Switch to the 10 nW range, apply 0.707 mV ±0.2%, and adjust R525 for a reading of 10 nW.

Adjustment No. 7 Switch to the 100 nW range, apply 2.236 mV ±0.2%, and adjust R524 for a reading of 100 nW.

Adjustment No. 8 Switch to the 1 μW range, apply 7.071 mV ±0.2%, and adjust R523 for a reading of 1 μW.

Adjustment No. 9 Switch to the 10 μW range, apply 22.36 mV ±0.2%, and adjust R522 for a reading of 10 μW.

Adjustment No. 10 Switch to the 100 μW range, apply 70.71 mV ±0.2%, and adjust R521 for a reading of 100 μW.

Adjustment No. 11 * Apply 22.36 mV ±0.2%, and adjust R543 for a reading of 10 μW.

Adjustment No. 12 Switch to the 1 mW range, apply 223.6 mV ±0.2%, and adjust R520 for a reading of 1 mW.

Adjustment No. 13 * Apply 70.71 mV ±0.2%, and adjust R548 for a reading of 100 μW.

Adjustment No. 14 Switch to the 10 mW scale, apply 707.1 mV ±0.2%, and adjust R519 for a reading of 10 mW.

Adjustment No. 15 * Apply 223.6 mV ±0.2% and adjust R562 for a reading of 1 mW.

** Adjustment No. 5 will only be necessary if the Power Detector has been changed.

*After adjusting these down-scale settings, go back and recheck the full-scale reading. There is some interlock between the high and the low scale adjustments.

NOTE

The following adjustments are normally made in the factory and are not usually changed by the operator. If the behavior of the instrument indicates that one or more of them are required, it is suggested that you call the factory for instructions.

*R632. Sets the -50 dBm point on the 10 nW range.

*R639. Sets the 10 dBm step between 10% scale and full scale.

R638. Edge meter calibration.

*R642. Gain adjustment for dBm converter.

**R716. Adjusts full-scale trip point on autorange card.

R1010. Digital indicator bias current adjustment.

R1011. Digital indicator MINUS full-scale adjustment.

R1016. Digital indicator zero set.

R1027. Digital indicator PLUS full scale adjustment.

*For dBm option only (42AD-09)
**For autoranging option only (42AD-01)

5.5 TROUBLE-SHOOTING

If unsatisfactory operation of the 42AD should develop, the following paragraphs outline the corrective action to be taken.

5.5.1 Cover Removal

The cover of the instrument case may be removed by taking out the screw located on the top of the case.

5.5.2 Chopper Replacement

The mechanical chopper is a possible source of difficulty. A new chopper should be tried as a first step. Note that the chopper used in the 42AD is a special Boonton

Electronics part; a spare or replacement can be obtained from your local Boonton representative or directly from the factory.

If a new chopper does not clear up the trouble, replace the original chopper in the socket. If the new part does correct the trouble, be sure to check the instrument's calibration before proceeding to use it.

5.5.3 Voltage and Resistance Tests

After eliminating the chopper as the source of trouble, a systematic check of the ac and dc voltages, resistances, and wave forms should be made. The schematic diagrams in the back of the manual show the test points, together with the voltage values and waveforms that should be observed at the points.

When the trouble has been corrected, the instrument's calibration should be checked and, if necessary, a full recalibration carried out as in Par. 5.4.

5.5.4 Power Detector Replacement

Each 42AD instrument is calibrated with its own power detector at the factory; the detector will bear the same serial number as the instrument with which it was tested. Should a new detector be used, or the original detector be repaired, the instrument and detector must be recalibrated.

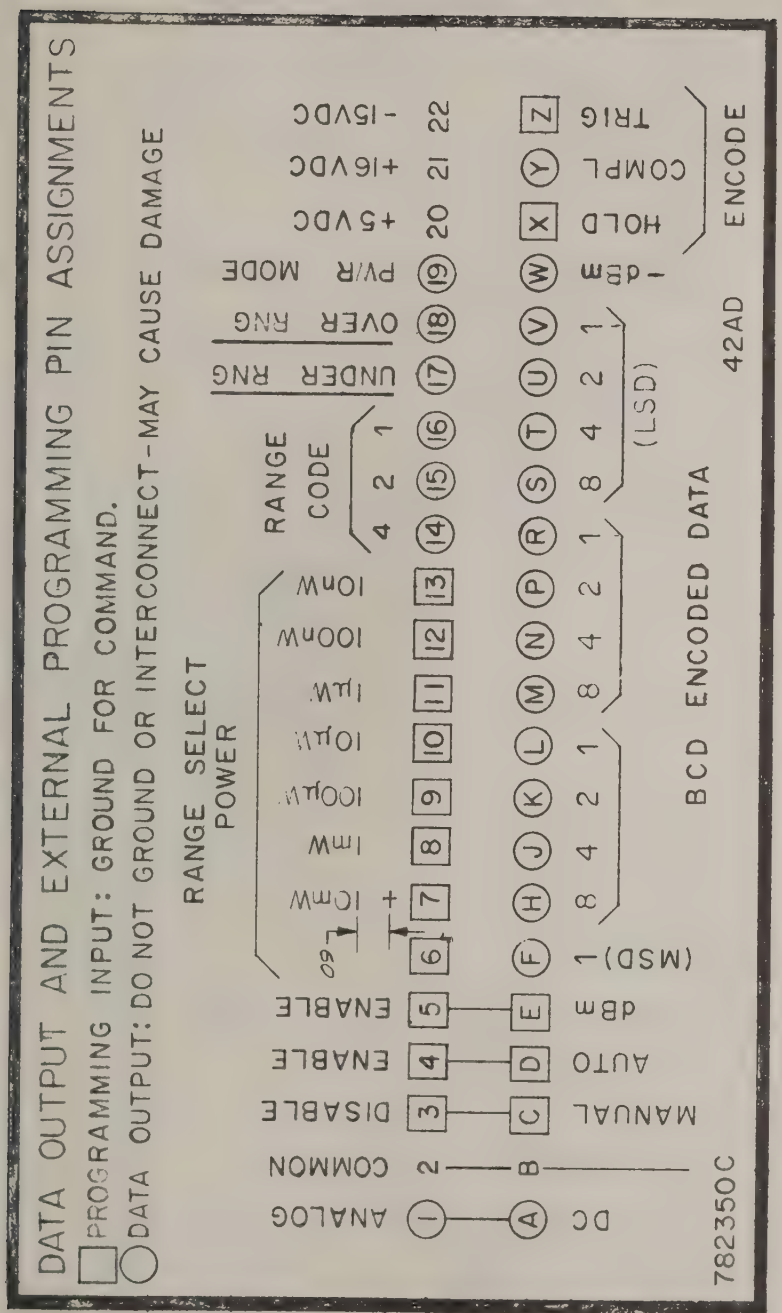


Figure 5. External Connections

Table 2. External Connections

TERMINAL	FUNCTION	REMARKS
A, 1	DC Analog Output	+10V F.S., $Z_o \approx 9\ k\Omega$
B, 2	Common	
C, 3	Manual Disable	Connect to common to disable front panel programming.
* D, 4	Autorange Enable	Connect to common to enable autorange operation. All external range lines must be unselected during autorange operation.
* E, 5	dBm Enable	Normally displays power. Connect to common to display dBm.
F	4th Digit Output	Logic 1 = 1 Logic 0 = 0
H	8 Bit	
J	4 "	
K	2 " 3rd Digit	BCD encoded data outputs
L	1 "	
M	8 Bit	Positive true logic
N	4 "	
P	2 " 2nd Digit	Logic 1 $\geq$ +3.0V
R	1 "	$Z_o \approx 150\Omega$
S	8 Bit	Logic 0 $\leq$ 0.5V
T	4 "	$Z_o \approx 75\Omega$
U	2 " 1st Digit	
V	1 " (LSD)	Maximum sink current at Logic Ø = 1.6 mA (1 Std. TTL load)
* W	- dBm Output	Logic 1 indicates negative dBm readings.
X	Encode Hold Input	Logic 1 inhibits start of new encode cycle. Allows extended or delayed data transfer operations.
Y	Encode Complete Output	Transfers from Logic 1 to Logic 0 at start of encode period. End of encode period is indicated by transfer from Logic 0 to Logic 1.
Z	Encode Trigger	An encode cycle is started by a transition from Logic 1 to Logic 0.

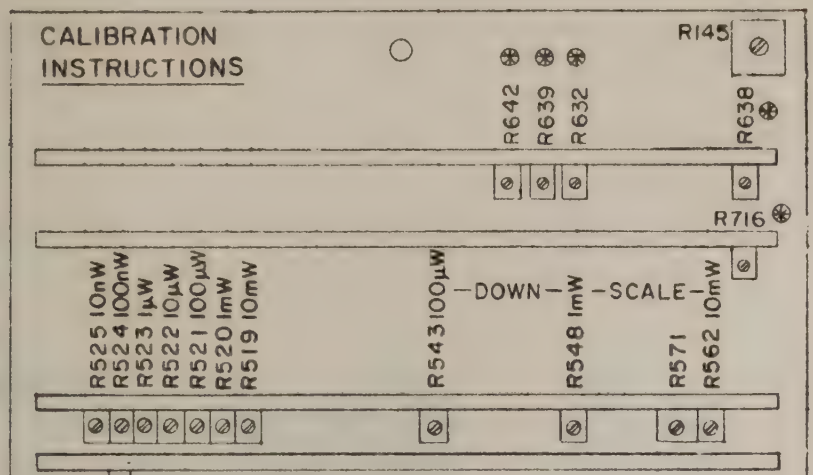
* = with appropriate equipment option

Table 2. External Connections (Cont'd)

TERMINAL	FUNCTION	REMARKS
7	10 mW	External range programming inputs. Select desired operating range by connecting corresponding line to common.
8	1 mW	
9	100 µW	
10	10 µW	
11	1 µW	
12	100 nW	
13	10 nW	
14	4 Bit Range	Indicates current operating range in binary encoded format.
15	2 " Code	
16	1 " Output	
		0 = 10 nW 1 = 100 nW 2 = 1 µW 3 = 10 µW 4 = 100 µW 5 = 1 mW 6 = 10 mW
17	Underrange not Output	Logic 0 indicates input signal less than 10% of programmed F. S. range.
18	Overrange not Output	Logic 0 indicates input signal greater than 105% of programmed F. S. range.
* 19	Power Mode Output	Logic 1 indicates readout in power. Logic 0 indicates readout in dBm.
20	+ 5 VDC	Power for BEC-supplied options or accessories only.
21	+16 VDC	
22	-15 VDC	

* = with appropriate equipment option.

42AD
a-471



ADJ NO	R	FUNCTION	RANGE	INPUT mV	ADJUST TO
1	145	-15V ADJ	-	-	-15.0 ± 0.1V
2	571	+15V ADJ	TP2	-	+15.0 ± 0.1V
3	401	FRONT PANEL ZERO	10nW	0	0
4	233	DC ZERO	10μW	0	0
5	151	SENS ADJ	1μW	7.071 ± 0.2%	-3.0V ± 1% TP1
6	525	F.S. RNG. ADJ	10nW	0.707 ± 0.2%	10nW
7	524	F.S. RNG. ADJ	100nW	2.236 ± 0.2%	100nW
8	523	F.S. RNG. ADJ	1μW	7.071 ± 0.2%	1μW
9	522	F.S. RNG. ADJ	10μW	22.36 ± 0.2%	10μW
10	521	F.S. RNG. ADJ	100μW	70.71 ± 0.2%	100μW
11	543	D.S. ADJ	100μW	22.36 ± 0.2%	10μW
12	520	F.S. RNG. ADJ	1mW	223.6 ± 0.2%	1mW
13	548	D.S. ADJ	1mW	70.71 ± 0.2%	100μW
14	519	F.S. RNG. ADJ	10mW	707.1 ± 0.2%	10mW
15	562	D.S. ADJ	10mW	223.6 ± 0.2%	1mW

Figure 6. Calibration Outline

TABLE OF REPLACEABLE PARTS

Reference	Description			BEC Part No.
A201	Operational Amplifier		Nat. Semi. LM302	535003
A301	"	"	" " LM301A	535002
A501	"	"	" " LM301A	535002
A502	"	"	" " LM301A	535002
A601	"	"	" " LM301A	535002
A602	"	"	" " LM301A	535002
C101	Capacitor	0.1 µF ± 10% 200V	Sprague 192P10402	234005
C102	"	10 µF ± 20% 20V	Kemet K01E20	283205
C103	"	100 pF ± 5% 500V	Arco DM15101-J	200001
C104	"	10 µF ± 20% 20V	Kemet K10E20	283205
C105	"	33 µF ± 20% 15V	Kemet K33E15	283206
C106	"	10 µF ± 20% 20V	Kemet K10E20	283205
C107	"	1.0 µF ± 20% 100V	Electron Prod. W1-105	236007
C108	"	1.0 µF ± 20% 35V	Kemet K1E35	283199
C109	"	50 µF 25V	Sprague TE1209	283159
C110	"	50 µF 25V	Sprague TE1209	283159
C111	"	0.1 µF ± 10% 200V	Sprague 192P10402	234005
C112	"	250 µF 40V	Mallory Type PFP	283207
C113	"	250 µF 40V	Mallory Type PFP	283207
C114	"	100 µF 25V	Sprague TE1211	283105
C115	"	100 µF 25V	Sprague TE1211	283105
C201	"	0.1µF ± 10% 50V	TRW 463UWU	234046
C202	"	0.0068 µF ± 10% 200V	Sprague 192P68292	234044
C203	"	100 pF ± 5% 500V	Arco DM15F101-J	200001
C204	"	100 pF ± 5% 500V	Arco DM15F101-J	200001
C205	"	0.022 µF 10% 200V	Sprague 192P22392	230101
C206	"	0.1 µF ± 10% 50V	TRW 463UWU	234046
C207	"	100 pF ± 5% 500V	Arco DM15F101-J	200001
C208	"	0.1 µF ± 10% 50V	TRW 463UWU	234046
C209	"	0.01 µF DISC. 100V	Erie 805-15V01032	224119
C210	"	0.01 µF DISC. 100V	Erie 805-15V01032	224119
C211	"	0.018 µF ±5% 200V	Sprague 192P18352	234064
C212	"	0.47 µF ± 10% 50V	TRW463UW	236023
C213	"	100 pF ± 5% 500V	Arco DM15F101-J	200001
C214	"	50 µF 25V	Sprague TE1209	283159
C215	"	50 µF 25V	Sprague TE1209	283159
C216	"	50 µF 25V	Sprague TE1209	283159

Reference		Description		BEC Part No.
C301	Capacitor	0.01 µF 100V	Erie 805-Y5V01032	224119
C302	"	33 pF ± 5% 500V	Arco DM-15-330-J	200049
C303	"	0.01 µF 100V	Erie 805-Y5V01032	224119
C401	"	0.1 µF ± 10% 50V	TRW 463 UWU	234046
C402	"	0.1 µF ± 10% 50V	TRW 463 UWU	234046
C501	"	0.01 µF 100V	Erie 805-Y5V0103Z	224119
C502	"	33 pF 5% 500V	Arco DM-15-330J	200049
C503	"	0.01 µF 100V	Erie 805-Y5V0103Z	224119
C504	"	0.01 µF 100V	Erie 805-Y5V0103Z	224119
C505	"	33 pF 5% 500V	Arco DM-15-330J	200049
C506	"	0.01 µF 100V	Erie 805-Y5V0103Z	224119
C601	"	0.01 µF 100V	Erie 805-Y5V0103Z	224119
C602	"	33 pF 5% 500V	Arco DM-15-330J	200049
C603	"	33 pF 5% 500V	Arco DM-15-330J	200049
C604	"	0.01 µF 100V	Erie 805-Y5V0103Z	224119
CR101	Diode	L Pwr. P1V 125 450 mA	Fairchild FD300	530052
CR102	"	L Pwr. Silicon	Texas Inst. 1N914	530058
CR103	"	L Pwr. Silicon	Texas Inst. 1N914	530058
CR104	", Zener	13V 5%	1N5243B	530101
CR105	", Zener	6.8V ± 5% 500 mW	Motorola 1N5235B	530089
CR106	Diode	L Pwr. Silicon	T. I. 1N914	530058
CR107	Rectifier, Sil.	1.5A 200V	Gen. Inst. KBP02	532013
CR108	Diode	L Pwr. Silicon	T. I. 1N914	530058
CR109	"	L Pwr. Silicon	T. I. 1N914	530058
CR110	"	L Pwr. Silicon	T. I. 1N914	530058
CR111	"	L Pwr. Silicon	T. I. 1N914	530058
CR112	Diode, Zener	17V 5%	Motorola 1N5247B	530100
CR113	", Zener	6.2V ±5% 500 mW	Motorola 1N5234B	530093
CR201	Diode	L Pwr. Silicon	T. I. 1N914	530058
CR202	"	" "	"	"
CR203	"	" "	"	"
CR204	"	" "	"	"
CR205	"	" "	"	"
CR206	"	" "	"	"
CR207	"	" "	"	"

Reference		Description		BEC Part No.
CR208	Diode	L Pwr. Silicon	T. I. 1N914	530058
CR209	"	" "	"	"
CR210	"	" "	"	"
CR211	"	" "	"	"
CR212	"	" "	"	"
CR213	"	" "	"	"
CR214	"	" "	"	"
CR215	"	" "	"	"
CR216	"	" "	"	"
CR217	"	" "	"	"
CR218	"	" "	"	"
CR219	"	125 P.I.V. 450 mA	Fairchild FD300	530052
CR301	Diode	L Pwr. Silicon	T. I. 1N914	530058
CR302	"	" "	"	"
CR303	"	" "	"	"
CR304	"	" "	"	"
CR305	"	" "	"	"
CR306	"	" "	"	"
CR307	"	" "	"	"
CR308	"	" "	"	"
CR401	Diode	L Pwr. Silicon	T. I. 1N914	530058
CR402	"	" "	"	"
CR403	"	" "	"	"
CR404	"	" "	"	"
CR405	"	" "	"	"
CR406	"	" "	"	"
CR407	"	" "	"	"
CR408	"	" "	"	"
CR409	"	" "	"	"
CR410	"	" "	"	"
CR501	Diode	L Pwr. Silicon	T. I. 1N914	530058
CR502	"	" "	"	"
CR503	"	" "	"	"

Reference		Description		BEC Part No.
CR504	Diode	L Pwr. Silicon	T. I. 1N914	530058
CR505	"	" "	"	"
CR506	"	" "	"	"
CR507	"	" "	"	"
CR508	"	" "	"	"
CR509	"	" "	"	"
CR510	"	" "	"	"
CR601	Diode	L Pwr. Silicon	T. I. 1N914	530058
CR602	"	" "	"	"
CR603	"	" "	"	"
CR604	"	" "	"	"
CR605	"	" "	"	"
CR606	"	" "	"	"
CR607	"	" "	"	"
CR608	"	" "	"	"
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CR616	"	" "	"	"
CR618	"	" "	"	"
CR619	"	" "	"	"
CR620	"	" "	"	"
CR621	"	" "	"	"
CR622	"	" "	"	"
CR623	"	" "	"	"
CR624	"	" "	"	"
CR625	"	" "	"	"
CR626	"	" "	"	"
CR627	"	" "	"	"
CR629	Diode, Zener	6.2V 5%	Motororola 1N5234B	530093
CR630	" "	"	"	"
F401	Fuse	0.2A 115V	Bussman MDL Slo-Blo	545508
or				
F401	Fuse	1/16A 220V	Bussman MDL Slo-Blo	554518

42AD
a-471

Reference		Description		BEC Part No.
G401	Chopper	Special	Airpax, Type 3 6	540113
J101	Connector	Card Edge, 22 Pos.	Amphenol 143-022-03	479231
J102	"	" " "	" "	"
J401	Receptacle		Amphenol 80-PC-2-FT	479119
M401	Digital Panel Meter			554220
M402	Meter and Scale			554233
Q101	FET	Junction, Silicon	Motorola 2N5459	528019
Q102	"	" "	" "	"
Q103	"	" "	" "	"
Q104	"	Silicon, N-Channel	T. I. S 58	528038
Q105	"	MOS-FET	Hughes HDGP-1001	528057
Q106	"	Junction, Silicon	Motorola 2N5459	528019
Q107	Transistor	Selected, Special		528044
Q108	"	NPN, Silicon	Motorola 2N5088	528047
Q109	"	PNP, Silicon	Motorola 2N5087	528042
Q110	"	PNP	Motorola MPS-A66	528048
Q111	"	PNP, Silicon	Motorola 2N5087	538042
Q112	"	PNP, Silicon	Motorola 2N5088	528047
Q113	FET	N-Channel, Silicon	T. I. TIS58	528038
Q114	"	N-Channel, Silicon	T. I. TIS58	528038
Q115	"	N-Channel, Silicon	T. I. TIS58	528038
Q116	"	Junction, Silicon	Motorola 2N5459	528019
Q117	"	" "	"	"
Q118	"	" "	"	"
Q119	Transistor	PNP	" MPS-A66	528048
Q120	"	NPN, Silicon	" 2N3903	528024
Q121	"	PNP, Silicon	" 2N3905	528025
Q122	FET	Junction, Silicon	" 2N5459	528019
Q123	"	" "	" 2N5459	528019
Q124	Transistor	NPN, Silicon	" 2N4921	528034
Q125	"	PNP, Silicon	" 2N4918	528033
Q126	"	PNP, Silicon	" 2N5087	528042
Q127	FET	MOS-FET	Hughes HDGP-1001	528057

Reference		Description		BEC Part No.
Q128	Transistor	MOS-FET	Hughes HDGP-1001	528057
Q201	Transistor	Unijunction, Silicon	Motorola 2N4871	528051
Q202	"	NPN, Silicon	" MPSA10	528043
Q203	"	PNP, Silicon	" 2N5087	528042
Q204	"	NPN, Silicon	" 2N5088	528047
Q205	"	NPN, Silicon	" MPSA10	528043
Q206	FET	Silicon	" MPS-A12	528052
Q207	Transistor	NPN, Silicon	" MPSA10	528043
Q208	"	N-Channel, Junction	T. I. TIS58	528038
Q209	"	NPN, Silicon	Motorola MPSA10	528043
Q210	"	N-Channel, Junction	T. I. TIS58	528038
Q211	FET	Junction, Silicon	Motorola 2N5459	528019
Q212	Transistor	NPN, Silicon	" MPSA10	528043
Q213	"	NPN, Silicon	" 2N5308	528050
Q214	"	NPN, Silicon	2N5308	528050
Q301	FET	Junction, Silicon	Motorola 2N5459	528019
Q302	"	" "	" "	"
Q303	"	" "	" "	"
Q304	Transistor	PNP, Silicon	" 2N5087	528042
Q305	FET	Junction, Silicon	" 2N5459	528019
Q306	Transistor	PNP, Silicon	" 2N5087	528042
Q307	FET	Junction, Silicon	" 2N5459	528019
Q308	Transistor	PNP, Silicon	" 2N5087	528042
Q309	FET	Junction, Silicon	" 2N5459	528019
Q310	Transistor	PNP, Silicon	" 2N5087	528042
Q311	FET	Junction, Silicon	" 2N5459	528019
Q312	Transistor	PNP, Silicon	" 2N5087	528042
Q313	FET	Junction, Silicon	" 2N5459	528019
Q314	"	" "	" "	"
Q315	"	" "	" "	"
Q316	"	" "	" "	"
Q317	Transistor	PNP, Silicon	" 2N5087	528042
Q318	"	NPN, Silicon	" 2N5088	528047
Q319	"	PNP, Silicon	" 2N5087	528042
Q320	"	NPN, Silicon	" 2N5088	528047
Q321	"	PNP, Silicon	" 2N5087	528042
Q322	"	PNP, Silicon	" 2N5087	528042

Reference		Description			BEC Part No.
Q323	FET	Junction, Silicon	Motorola	2N5459	528019
Q324	"	" "		"	"
Q325	Transistor	PNP, Silicon	"	2N5087	528042
Q326	FET	Junction, Silicon	"	2N5459	528019
Q327	Transistor	PNP, Silicon	"	2N5087	528042
Q328	FET	Junction, Silicon	"	2N5459	528019
Q329	Transistor	PNP, Silicon	"	2N5087	528042
Q330	FET	Junction, Silicon	"	2N5459	528019
Q331	"	" "	"	2N5459	528019
Q332	Transistor	PNP, Silicon	"	2N5087	528042
Q333	"	" "	"	2N5087	528042
Q334	"	" "	"	2N5087	528042
Q338	Transistor	PNP, Silicon	"	2N5087	528042
Q339	"	" "	"	2N5087	528042
Q501	Transistor	NPN, Silicon	Motorola	2N5088	528047
Q502	"	" "	"		"
Q503	"	FET, Silicon	"	2N5459	528019
Q504	"	" "	"	"	"
Q505	"	" "	"	"	"
Q506	"	" "	"	"	"
Q507	"	" "	"	"	"
Q508	"	" "	"	"	"
Q509	"	" "	"	"	"
Q510	"	NPN, Silicon	"	2N5088	528047
Q511	"	" "	"	"	"
Q512	"	" "	"	"	"
Q513	"	" "	"	"	"
Q514	"	FET, Silicon	T. I.	TIS58	528038
Q515	"	NPN, Silicon	Motorola	2N5088	528047
Q516	"	FET, Silicon	T. I.	TIS58	528038
Q517	"	NPN, Silicon	Motorola	2N5088	528047
Q518	"	FET, Silicon	T. I.	TIS58	528038
Q519	"	NPN, Silicon	Motorola	2N5088	528047
Q520	"	FET, Silicon	T. I.	TIS58	528038
Q521	"	NPN, Silicon	Motorola	2N5088	528047
Q522	"	" "	"		"
Q523	"	" "	"		"
Q524	"	" "	"		"
Q525	"	" "	"		"
Q526	"	FET, Silicon	T. I.	TIS58	528038
Q527	"	NPN, Silicon	Motorola	2N5088	528047
Q528	"	" "	"		"

Reference		Description		BEC Part No.
Q529	Transistor	NPN, Silicon	Motorola 2N5088	528047
Q530	"	" "	"	"
Q531	"	" "	"	"
Q532	"	" "	"	"
Q533	"	" "	"	"
Q534	"	" "	"	"
Q535	"	" "	"	"
Q601	Transistor	FET, Silicon	Motorola 2N5653	528056
Q602	"	" "	"	"
Q603	"	" "	"	"
Q605	"	FET, Junction	" 2N5459	528019
Q607	"	" "	" "	"
Q608	"	" "	" "	"
Q609	"	" "	" "	"
Q610	"	" "	" "	"
Q611	"	" "	" "	"
Q612	"	NPN, Silicon	Motorola MPS-A10	528043
Q613	"	" "	"	"
Q615	"	" "	"	"
R101	Resistor	1M 1/2W 5%	AB EB	301159
R102	"	3.9 kΩ 1/4W 5%	AB CB	300096
R103	"	3.9 kΩ 1/4W 5%	AB CB	300096
R104	"	5.62M 1/4W 1%	Pyrofilm MPE65	325397
R106	"	52.3K 3/8W 1%	T. I. MC60D	340445
R107	"	232 kΩ 3/8W 1%	T. I. MC60D	340522
R109	"	1.00M 3/8W 1%	T. I. MC60D	326700
R110	"	91 K 1/2W 5%	T. I. MC60D	301134
R111	"	41 K 1/2W 5%	T. I. MC60D	301127
R112	"	33 K 1/2W 5%	T. I. MC60D	301123
R113	"	300 K 1/2W 5%	T. I. MC60D	301146
R114	"	150 Ω 3/8W 1%	T. I. MC60D	340141
R115	"	10 K 1/2W 5%	AB EB	301111
R116	"	10 K 1/2W 5%	AB EB	301111
R117	"	33 K 1/2W 5%	AB EB	301123
R118	"	15 K 3/8W 5%	T. I. MC60D	340378
R119	"	15 K 1/2W 5%	AB EB	301115
R120	"	3.6 K 1/2W 5%	AB EB	301100
R121	"	3 K 1/2W 5%	AB EB	301098

Reference		Description		BEC Part No.
R122	Resistor	1 M 1/2W 5%	AB EB	301159
R123	"	2.7 K 1/2W 5%	AB EB	301097
R124	"	5.6 K 1/2W 5%	AB EB	301105
R125	"	5.6 K 1/2W 5%	AB EB	301105
R126	"	1 K 1/2W 5%	AB EB	301087
R127	"	5.1 K 1/2W 5%	AB EB	301104
R128	"	15 K 1/2W 5%	AB EB	301115
R129	"	1 K 1/2W 5%	AB EB	301087
R130	"	10 K 1/2W 5%	AB EB	301111
R131	"	30.1 K 3/8W 1%	T. I. MC60D	326397
R132	"	3.01 K 3/8W 1%	T. I. MC60D	326297
R133	"	301 Ω 3/8W 1%	T. I. MC60D	340176
R134	"	33.2 Ω 3/8W 1%	T. I. MC60D	340063
R135	"	1 M 1/2W 5%	AB EB	301159
R136	"	2 K 1/2W 5%	AB EB	301094
R137	"	24 K 1/2W 5%	AB EB	301120
R138	"	24 K 1/2W 5%	AB EB	301120
R139	"	2 K 1/2W 5%	AB EB	301094
R140	"	8.2 Ω 1/2W 5%	AB EB	301505
R141	"	3.9 Ω 5% 1/2W	AB EB	301507
R142	"	100 Ω 1/4W 5%	AB CB	300058
R143	"	100 Ω 1/4W 5%	AB CB	300058
R144	"	3.92 K 3/8W 5%	T. I. MC60D	340311
R145	"	1 K 1/2W 20%	CTS 360T102B	311257
R146	"	4.75 K 3/8W 1%	T. I. MC60D	340321
R148	"	9.09 K 3/8W 1%	T. I. MC60D	340354
R149	"	150 kΩ 1/2W 5%	AB EB	301139
R150	"	121 Ω 3/8W 1%	T. I. MC60D	340129
R151	Resistor, Var.	100 Ω 20%	CTS 360PC101B	311277
R201	Resistor	10 K 1/2W 5%	AB EB	301111
R202	"	33 K 1/2W 5%	AB EB	301123
R203	"	10 K 1/2W 5%	AB EB	301111
R204	"	100 Ω 1/2W 5%	AB EB	301063
R205	"	33 K 1/2W 5%	AB EB	301123
R206	"	10 K 1/2W 5%	AB EB	301111
R207	"	100 K 1/2W 5%	AB EB	301135
R208	"	3.3 K 1/2W 5%	AB EB	301099
R209	"	4.7 K 1/2W 5%	AB EB	301103
R210	"	10 K 1/2W 5%	AB EB	301111
R211	"	150 K 1/2W 5%	AB EB	301139

Reference		Description		BEC Part No.
R212	Resistor	10 K 1/2W 5%	AB EB	301111
R213	"	10 K 1/2W 5%	AB EB	301111
R214	"	22 K 1/2W 5%	AB EB	301119
R215	"	10 K 1/2W 5%	AB EB	301111
R216	"	270 K 1/2W 5%	AB EB	301145
R217	"	240 K 1/2W 5%	AB EB	301144
R218	"	10 K 1/2W 5%	AB EB	301111
R219	"	15 K 1/2W 5%	AB EB	301115
R220	"	10 K 1/2W 5%	AB EB	301111
R221	"	10 K 1/2W 5%	AB EB	301111
R222	"	12 K 1/2W 5%	AB EB	301113
R223	"	4.7 kΩ 1/2W 5%	AB EB	301103
R224	"	12 K 1/2W 5%	AB EB	301113
R225	"	100 K 1/2W 5%	AB EB	301135
R226	"	100 K 1/2W 5%	AB EB	301135
R227	"	15 K 1/2W 5%	AB EB	301135
R228	"	10 K 1/2W 5%	AB EB	301111
R229	"	100 K 1/2W 5%	AB EB	301135
R230	"	12 K 1/2W 5%	AB EB	301113
R231	"	4.7 K 1/2W 5%	AB EB	301103
R232	"	100 K 1/2W 5%	AB EB	301135
R233	Trimmer	2 K	Bourns 3007P-1-202	311264
R234	Resistor	100 K 1/2W 5%	AB EB	301135
R235	"	100 K 1/2W 5%	AB EB	301135
R236	"	27 K 1/2W 5%	AB EB	301121
R237	"	100 K 1/2W 5%	AB EB	301135
R238	"	100 K 1/2W 5%	AB EB	301135
R239	"	1.6 K 1/2W 5%	AB EB	301092
R240	"	300 Ω 1/2W 5%	AB EB	301074
R241	"	62 Ω 1W 5%	AB GB	302072
R242	"	150 K 1/2W 5%	AB EB	301139
R243	"	510 K 1/2W 5%	AB EB	301152
R301	Resistor	130 Ω 1/2W	AB EB	301066
R302	"	470 K 1/2W 5%	AB EB	301151
R303	Var. Resistor	1000 Ω	Bourns 3007P-1-102	311256
R304	Resistor	10 K 3/8W 1%	T. I. MC60D	326376
R305	"	470 K 1/2W 5%	AB EB	301151
R306	"	51.1 kΩ 3/8W 1%	T. I. MC60D	340443
R307	"	2.49 K 3/8W 1%	T. I. MC60D	340287
R308	Var. Resistor	1000 Ω	Bourns 3007P-1-102	311256
R309	Resistor	28.7 kΩ 3/8W 1%	T. I. MC60D	340414
R310	"	205 kΩ 3/8W 1%	T. I. MC60D	340516
R311	"	100 K 3/8W 1%	T. I. MC60D	340478

Reference		Description		BEC Part No.
R312	Resistor	39.2 kΩ 3/8W 1%	T. I. MC60D	340430
R313	"	182 kΩ 3/8W 1%	T. I. MC60D	340510
R314	"	11 K 3/8W 1%	T. I. MC60D	340364
R315	"	470 K 1/2W 5%	T. I. MC60D	301151
R316	"	28.7 kΩ 3/8W 1%	T. I. MC60D	340414
R317	"	97.6 kΩ 3/8W 1%	T. I. MC60D	340477
R318	Var. Resistor	1000 Ω	Bourns 3007P-1-102	311256
R319	Resistor	28.0 K 3/8W 1%	T. I. MC60D	340412
R320	"	64.9 kΩ 3/8W 1%	T. I. MC60D	340456
R321	"	100 M 3/8W 1%	T. I. MC60D	326700
R322	"	24.9 K 3/8W 1%	T. I. MC60D	326389
R323	"	46.4 K 3/8W 1%	T. I. MC60D	340438
R324	"	10 K 3/8W 1%	T. I. MC60D	326376
R325	"	470 K 1/2W 5%	T. I. MC60D	301151
R326	"	38.3 kΩ 3/8W 1%	T. I. MC60D	340428
R327	"	2.49 K 3/8W 1%	T. I. MC60D	340287
R328	Var. Resistor	1000 Ω	Bourns 3007P-1-102	311256
R329	Resistor	390 kΩ 1/2W 5%	AB EB	301149
R330	"	21.0 kΩ 3/8W 1%	T. I. MC60D	340399
R331	"	154 kΩ 3/8W 1%	T. I. MC60D	340501
R332	"	39 kΩ 1/2W 5%	AB EB	301125
R333	"	33.2 kΩ 3/8W 1%	T. I. MC60D	340421
R334	"	154 K 3/8W 1%	T. I. MC60D	340501
R335	"	47 K 1/2W 5%	AB EB	301127
R336	"	41.2 kΩ 3/8W 1%	T. I. MC60D	340432
R337	"	124 kΩ 3/8W 1%	T. I. MC60D	340490
R338	"	470 K 1/2W 5%	AB EB	301151
R339	"	59.0 kΩ 3/8W 1%	T. I. MC60D	340451
R340	"	127 kΩ 3/8W 1%	T. I. MC60D	340491
R341	Var. Resistor	1000 Ω	Bourns 3007P-1-102	311256
R342	Resistor	41.2 kΩ 3/8W 1%	T. I. MC60D	340432
R343	"	2.74 K 3/8W 1%	T. I. MC60D	340292
R344	"	470 K 1/2W 5%	AB EB	301151
R345	"	22.1 kΩ 3/8W 1%	T. I. MC60D	326385
R346	"	294 kΩ 3/8W 1%	T. I. MC60D	340535
R347	Var. Resistor	1000 Ω	Bourns 3007P-1-102	311256
R348	Resistor	37.4 kΩ 3/8W 1%	T. I. MC60D	340427
R349	"	309 kΩ 3/8W 1%	T. I. MC60D	340537
R350	"	470 K 1/2W 5%	AB EB	301151
R351	"	69.8 kΩ 3/8W 1%	T. I. MC60D	340460
R352	"	255 kΩ 3/8W 1%	T. I. MC60D	340527
R353	Var. Resistor	1000 Ω	Bourns 3007P-1-102	311256
R354	Resistor	16.5 K 3/8W 1%	T. I. MC60D	326381
R355	"	2.49 K 3/8W 1%	T. I. MC60D	340287
R356	"	33.2 kΩ 3/8W 1%	T. I. MC60D	340421
R357	"	499 kΩ 3/8W 1%	T. I. MC60D	326561

Reference		Description		BEC Part No.
R359	Resistor	64.9 kΩ 3/8W 1%	T. I. MC60D	340456
R360	"	324 kΩ 3/8W 1%	T. I. MC60D	340540
R401	Var. Resistor	8 kΩ 10%	Fenwal JA38J1	325008
R402	Resistor	76 kΩ 3/8W 1%	T. I. MC60D	340465
R403	"	499 kΩ 3/8W 1%	T. I. MC60D	326561
R404	"	590 kΩ 3/8W 1%	T. I. MC60D	340571
R405	"	499 kΩ 3/8W 1%	T. I. MC60D	326561
R406	"	226 kΩ 3/8W 1%	T. I. MC60D	340521
R407	"	715 kΩ 3/8W 1%	T. I. MC60D	340581
R408	"	82 kΩ 1/2W 5%	AB EB	301133
R409	"	2.7 kΩ 1/2W 5%	AB EB	301097
R501	Resistor	470 kΩ 1/2W 5%	AB EB	301151
R502	"	"	"	"
R503	"	"	"	"
R504	"	"	"	"
R505	"	"	"	"
R506	"	"	"	"
R507	"	"	"	"
R508	"	10 kΩ 3/8W 1%	T. I. MC60D	326376
R509	"	"	"	"
R510	"	10.5 kΩ 3/8W 1%	T. I. MC60D	340362
R511	"	182 kΩ 3/8W 1%	T. I. MC60D	340510
R512	"	866 kΩ 3/8W 1%	T. I. MC60D	340591
R513	"	1.0 MΩ 3/8W 1%	T. I. MC60D	326700
R514	"	100 kΩ 3/8W 1%	T. I. MC60D	340478
R515	"	10 kΩ 3/8W 1%	T. I. MC60D	326376
R516	"	232 kΩ 3/8W 1%	T. I. MC60D	340522
R517	"	536 kΩ 3/8W 1%	T. I. MC60D	340566
R518	"	14.3 kΩ 3/8W 1%	T. I. MC60D	340377
R519	Resistor, Var.	1000 Ω	Bourns 3007P-1-102	311256
R520	" "	"	"	"
R521	" "	"	"	"
R522	" "	"	"	"
R523	" "	"	"	"
R524	" "	"	"	"
R525	" "	"	"	"
R526	Resistor	309 kΩ 3/8W 1%	T. I. MC60D	340298
R527	"	"	"	"

Reference		Description		BEC Part No.
R528	Resistor	309 kΩ 3/8W 1%	T. I. MC60D	340298
R529	"	4.42 kΩ 3/8W 1%	T. I. MC60D	340317
R530	"	180 Ω 1/2W 5%	AB EB	301069
R531	"	93.1 kΩ 3/8W 1%	T. I. MC60D	340475
R532	"	787 kΩ 3/8W 1%	T. I. MC60D	340586
R533	"	86.6 kΩ 3/8W 1%	T. I. MC60D	340471
R534	"	392 kΩ 3/8W 1%	T. I. MC60D	340550
R535	"	1.0 MΩ 1/2W 5%	AB EB	301159
R536	"	158 kΩ 3/8W 1%	T. I. MC60D	340504
R537	"	536 kΩ 3/8W 1%	T. I. MC60D	340566
R538	"	60.4 kΩ 3/8W 1%	T. I. MC60D	340452
R539	"	154 kΩ 3/8W 1%	T. I. MC60D	340501
R540	"	1.0 MΩ 1/2W 5%	AB EB	301159
R541	"	100 kΩ 3/8W 1%	T. I. MC60D	340478
R542	"	210 kΩ 3/8W 1%	T. I. MC60D	340521
R543	Resistor, Var.	20 kΩ	Bourns 3007p-1-203	311266
R544	Resistor	22.6 kΩ 3/8W 1%	T. I. MC60D	340401
R545	"	1.0 MΩ 1/2W 5%	AB EB	301159
R546	"	42.2 kΩ 3/8W 1%	T. I. MC60D	326401
R547	"	274 kΩ 3/8W 1%	"	340531
R548	" Var.	20 kΩ	Bourns 3007P-1-203	311266
R549	"	53.6 kΩ 3/8W 1%	T. I. MC60D	340446
R550	"	226 kΩ 3/8W 1%	"	340521
R551	"	39.2 kΩ 3/8W 1%	"	340430
R552	"	118 kΩ 3/8W 1%	"	340487
R553	"	49.9 kΩ 3/8W 1%	"	326442
R554	"	110 kΩ 3/8W 1%	"	340483
R555	"	40.2 kΩ 3/8W 1%	"	326401
R556	"	73.3 kΩ 3/8W 1%	"	340462
R557	"	28.0 kΩ 3/8W 1%	"	340412
R558	"	1.0 MΩ 1/2W 5%	AB EB	301159
R559	"	10 kΩ 1/2W 5%	AB EB	301111
R560	"	29.4 kΩ 3/8W 1%	T. I. MC60D	340415
R561	"	158 kΩ 3/8W 1%	T. I. MC60D	340504
R562	" Var.	20 kΩ	Bourns 3007P-1-203	311266
R563	"	10 kΩ 1/2W 5%	AB EB	301111
R564	"	"	"	"
R565	"	43.2 kΩ 3/8 1%	T. I. MC60D	340435
R566	"	169 kΩ 3/8W 1%	"	340506
R567	"	10 kΩ 3/8W 1%	"	326376
R568	"	35.7 kΩ 3/8W 1%	"	340425
R569	"	97.6 kΩ 3/8W 1%	"	340477
R570	"	15 kΩ 1/2W 5%	AB EB	301115
R571	" Var.	1000 Ω	CTS 360PC102B	311276
R572	"	47 Ω 1/2W 5%	AB EB	301055
R573	"	42.2 kΩ 3/8W 1%	T. I. MC60D	340433

Reference		Description		BEC Part No.
R574	Resistor	100 kΩ 3/8W 1%	T. I. MC60D	340478
R575	"	30.1 kΩ 3/8W 1%	"	326397
R576	"	57.6 kΩ 3/8W 1%	"	340450
R577	"	47 Ω 1/2W 5%	AB EB	301055
R578	"	"	"	"
R601	Resistor	4.7 kΩ 1/2W 5%	AB EB	301103
R602	"	1.0 MΩ 1/4W 5%	AB CB	300154
R603	"	4.7 kΩ 1/2W 5%	AB EB	301103
R604	"	1.0 MΩ 1/4W 5%	AB CB	300154
R605	"	4.7 kΩ 1/2W 5%	AB EB	301103
R606	"	1.0 MΩ 1/4W 5%	AB CB	300154
R607	"	4.7 kΩ 1/2W 5%	AB EB	301103
R608	"	47 kΩ 1/2W 5%	AB EB	301127
R609	"	1.0 MΩ 1/4W 5%	AB CB	300154
R610	"	"	"	"
R611	"	"	"	"
R612	"	30 kΩ 1/2W 5%	AB EB	301122
R613	"	1.0 MΩ 1/4W 5%	AB CB	300154
R614	"	"	"	"
R615	"	"	"	"
R616	"	4.7 kΩ 1/2W 5%	AB EB	301103
R617	"	22 kΩ 1/2W 5%	"	301109
R618	"	"	"	301109
R619	"	22 kΩ 1/2W 5%	"	"
R620	"	4.7 kΩ 1/2W 5%	"	301103
R625	"	62 kΩ 1/2W 5%	AB EB	301130
R626	"	43 kΩ 1/2W 5%	"	301126
R628	"	140 kΩ 3/8W 1%	T. I. MC60D	340496
R629	"	100 kΩ 3/8W 1%	"	340478
R630	"	750 kΩ 3/8W 1%	"	326583
R632				
R637	"	9.76 kΩ 3/8W 1%	T. I. MC60D	340477
R638	" Var.	2 kΩ 1W 10%	Bourns 3007P-1-202	311264
R648	"	2.49 kΩ 3/8W 1%	T. I. MC60D	340287
R650	"	10 kΩ 3/8W 1%	"	326376
R651	"	12.4 kΩ 3/8W 1%	"	326377
RT301	Thermistor	100 Ω 10%	Fenwal CB21J1	325005
RT501	"	"	"	"
T401	Transformer	Power		446056

SUPPLEMENTAL TABLE OF REPLACEABLE PARTS

MODEL 42AD-01

(Autoranging Option)

Reference		Description		BEC Part No.
A701	Operational Amp.		Nat. Semi. LM301A	535002
A702	" "		" "	"
C701	Capacitor	33 pF 5% 500V	Arco DM-15-330V	200049
C702	"	0.01 µF 100V	Erie 805-Y5V0103Z	224119
C703	"	" "	" "	"
C704	"	1 µF 20% 35V	Sprague 196D105X0035DB	283199
C705	"	33 pF 5% 500V	Arco DM-15-330V	200049
C706	"	100 pF 5% 500V	Arco DM-15F-101J	200001
C707	"	" "	" "	"
C708	"	" "	"	
C709	"	" "	" "	"
C710	"	50 µF 25V	Sprague TE1209	283159
C711	"	200 pF 5% 500V	Arco DM-15F-201J	200004
C712	"	" "	" "	"
C713	"	" "	" "	"
C714	"	" "	" "	"
C715	"	" "	" "	"
C716	"	" "	" "	"
CR701 to CR749	Diode		T. I. 1N914	530058
CR750	Diode		Motorola 1N5234B	530093
Q701	Transistor	Unijunction	G.E. D5K2	528036
Q702 to Q710	"	PNP Silicon	Mot. MPS6516	528037
Q711	"	NPN Silicon	Mot. MPS6512	528059
Q712 to Q725	"	PNP Silicon	Mot. MPS6516	528037

Reference		Description		BEC Part No.
R701	Resistor	47K 5% 1/2W	AB EB	301127
R702	"	10K 5% 1/2W	"	301111
R703	"	" "	"	"
R704	"	62K 5% 1/2W	"	301130
R705	"	100K 5% 1/2W	"	301135
R706	"	31.6 K 1% 3/8W	T. I. MC60D	340418
R707	"	47K 5% 1/2W	AB EB	301127
R708	"	" "	"	"
R709	"	10K 5% 1/2W	AB EB	01111
R710	"	47K 5% 1/2W	"	301127
R711	"	95.3 kΩ 3/8W 1%	T. I. MC60D	340476
R712	"	47K 5% 1/2W	AB EB	301127
R713	"	10K 5% 1/2W	"	301111
R714	"	47K 5% 1/2W	"	301127
R715	"	40.2K 1% 3/8W	T. I. MC60D	326401
R716	" Var.	20K 10% 1W	Bourns 3007P-1-203	311266
R717	"	10Ω 5% 1/2W	AB EB	301039
R718	"	10K 5% 1/2W	"	301111
R719	"	330K 5% 1/2W	"	301147
R720	"	" "	"	301147
R721	"	" "	"	"
R722	"	" "	"	"
R723	"	15K 5% 1/2W	"	301115
R724	"	10K 5% 1/2W	"	301111
R725	"	47K 5% 1/2W	"	301127
R726	"	" "	"	301127
R727	"	" "	"	301127
R728	"	" "	"	301127
R729	"	470Ω 5% 1/2W	"	301079
R730	"	47K 5% 1/2W	"	301127
R731	"	10K 5% 1/2W	"	301111
R732	"	47K 5% 1/2W	"	301127
R733	"	10K 5% 1/2W	"	301111
R734	"	47K 5% 1/2W	"	301127
R735	"	10K 5% 1/2W	"	301111
R736	"	47K 5% 1/2W	"	301127
R737	"	10K 5% 1/2W	"	301111
R738	"	47K 5% 1/2W	"	301127
R739	"	10K 5% 1/2W	"	301111
R740	"	47K 5% 1/2W	"	301127
R741	"	10K 5% 1/2W	"	301111
R742	"	47K 5% 1/2W	"	301127
R743	"	10K 5% 1/2W	"	301111
R744	"	47K 5% 1/2W	"	301127
R745	"	10K 5% 1/2W	"	301111
R746	"	" "	"	"

Reference		Description		BEC Part No.
R747	Resistor	10K 5% 1/2W	AB EB	301111
R748	"	" "	"	"
R749	"	" "	"	"
R750	"	" "	"	"
R751	"	" "	"	"
R752	"	47K 5% 1/2W	"	"
R753	"	" "	"	"
R754	"	" "	"	"
R755	"	" "	"	"
R756	"	" "	"	"
R757	"	" "	"	"

SUPPLEMENTAL TABLE OF REPLACEABLE PARTS

MODEL 42AD-02
(Logic-Level Programming Option)

Reference		Description		BEC Part No.
CR801 to CR811	Diode		T. I. 1N4148	530096
Q801 to Q811	Transistor	PNP Silicon	Mot. MPS 6516	528037
R801	Resistor	160K 5% 1/8W	AB BB	331135
R802	"	39K 5% 1/8W	"	331120
R803	"	100K 5% 1/8W	"	331130
R804	"	160K 5% 1/8W	"	331135
R805	"	39K 5% 1/8W	"	331120
R806	"	100K 5% 1/8W	"	331130
R807	"	160K 5% 1/8W	"	331135
R808	"	39K 5% 1/8W	"	331120
R809	"	100K 5% 1/8W	"	331130
R810	"	160K 5% 1/8W	"	331135
R811	"	39K 5% 1/8W	"	331120
R812	"	100K 5% 1/8W	"	331130
R813	"	160K 5% 1/8W	"	331135
R814	"	39K 5% 1/8W	"	331120
R815	"	100K 5% 1/8W	"	331130
R816	"	160K 5% 1/8W	"	331135
R817	"	39K 5% 1/8W	"	331120
R818	"	100K 5% 1/8W	"	331130
R819	"	160K 5% 1/8W	"	331135
R820	"	39K 5% 1/8W	"	331120
R821	"	100K 5% 1/8W	"	331130
R822	"	160K 5% 1/8W	"	331135
R823	"	39K 5% 1/8W	"	331120
R824	"	100K 5% 1/8W	"	331130
R825	"	160K 5% 1/8W	"	331135
R826	"	39K 5% 1/8W	"	331120
R827	"	100K 5% 1/8W	"	331130
R828	"	160K 5% 1/8W	"	331135
R829	"	39K 5% 1/8W	"	331120
R830	"	100K 5% 1/8W	"	331130
R831	"	160K 5% 1/8W	"	331135
R832	"	39K 5% 1/8W	"	331120
R833	"	100K 5% 1/8W	"	331130

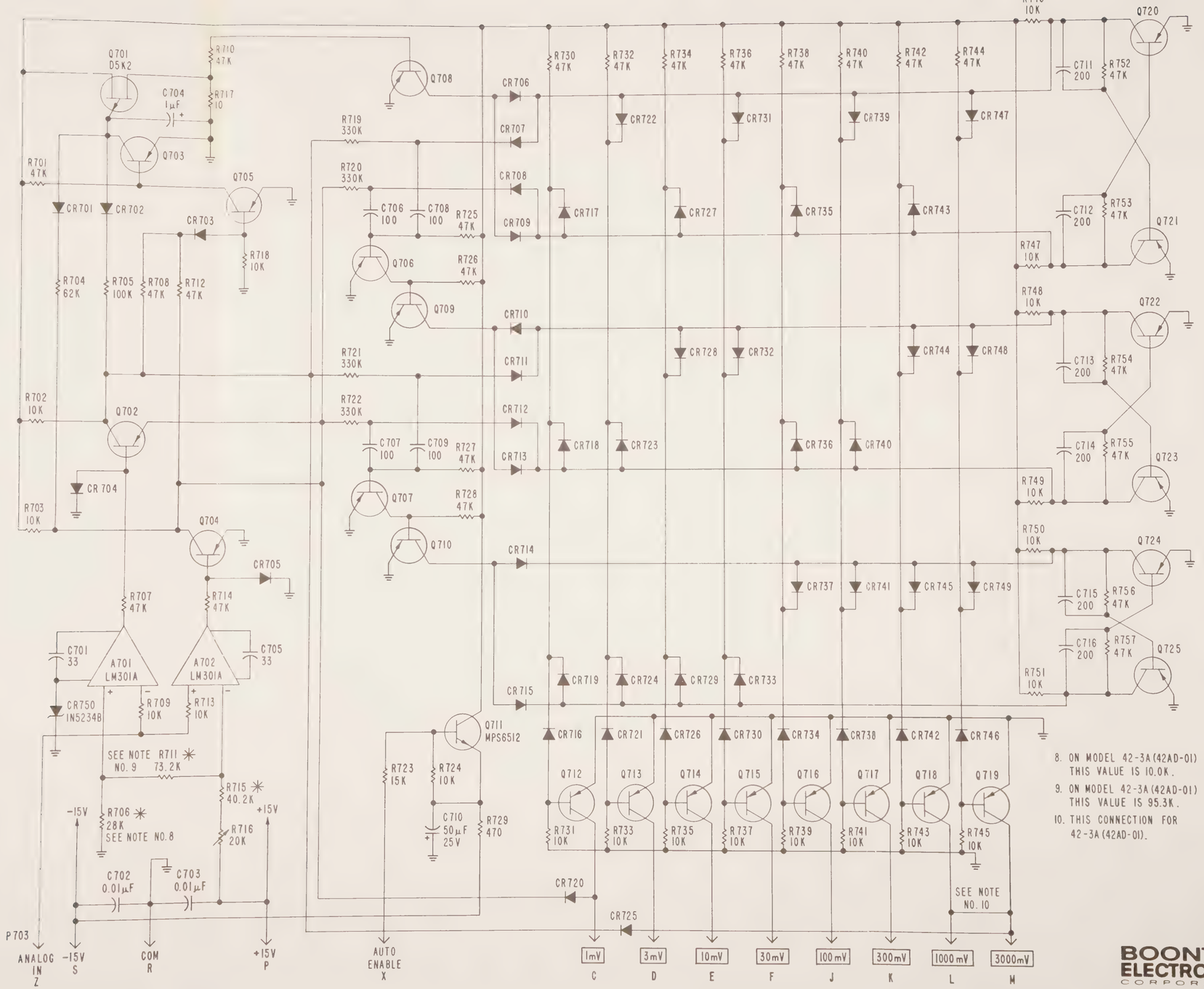
SUPPLEMENTAL PARTS LIST

MODEL 42AD-09

(dBm/Power Readout)

Reference		Description		BEC Part No.
A603	Operational Amplifier		Nat. Semi LM-301A	535002
A604	" "		" "	"
A605	" "		" "	"
C605	Capacitor	150 pF 5% 500V	Arco DM-15-151J	200032
C606	"	20 pF 5% 500V	Arco DM-10-200J	200027
C607	"	33 pF 5% 500V	Arco DM-15-330J	200049
C608	"	300 pF 5% 500V	Arco DM-15-301J	200034
C609	"	"	"	"
CR617	Diode	Low Pwr. Silicon	T. I. 1N914	530058
CR628	"	"	"	"
CR631	"	Silicon Zener 6.2V	Motorola 1N821	530050
R618	Resistor	10 kΩ 5% 1/4W	AB CB	300130
R621	"	1.00 MΩ 0.1% 3/8W	T. I. MC60D	340599
R623	"	1.1 kΩ 5% 1/2W	AB EB	301088
R624	"	500 kΩ 0.1% 3/8W	T. I. MC60D	340564
R627	"	250 kΩ 0.1% 3/8W	"	340526
R632	" Var.	20 kΩ 10% 1W	Bourns 3007P-1-203	311266
R633	"	71.5 kΩ 1% 3/8W	T. I. MC60D	340461
R635	"	64.9 kΩ 1% 3/8W	"	340456
R636	"	68 kΩ 5% 1/2W	AB EB	301131
R639	" Var.	5 kΩ 10% 1W	Bourns 3007P-1-502	311268
R640	"	64.9 kΩ 1% 3/8W	T. I. MC60D	340456
R641	"	15.8 kΩ 1% 3/8W	"	340382
R642	" Var.	5 kΩ 10% 1W	Bourns 3007P-1-502	311268
R643	"	39 kΩ 5% 1/2W	AB EB	301125
R644	"	2 kΩ 5% 1/2W	" "	301125
R645	"	66.5 kΩ 1% 3/8W	T. I. MC60D	340457
R647	"	2.49 kΩ 1% 3/8W	"	340287
RT601	Thermistor	1 kΩ 1%	Tellabs Q81	325006

Reference		Description		BEC Part No.
Q604	Transistor	FET	Motorola 2N5653	528056
Q606	"	NPN Silicon	" MPS-A10	528043
Q614	"	MOS FET	Hughes HDGP-1001	528057
Q616	"	" "	"	"
Q617	"	" "	"	"
Q618	"	Dual NPN	RCA CA3046	528058
Q619	"	FET	Motorola 2N5653	528056
Q620	"	Selected		528060

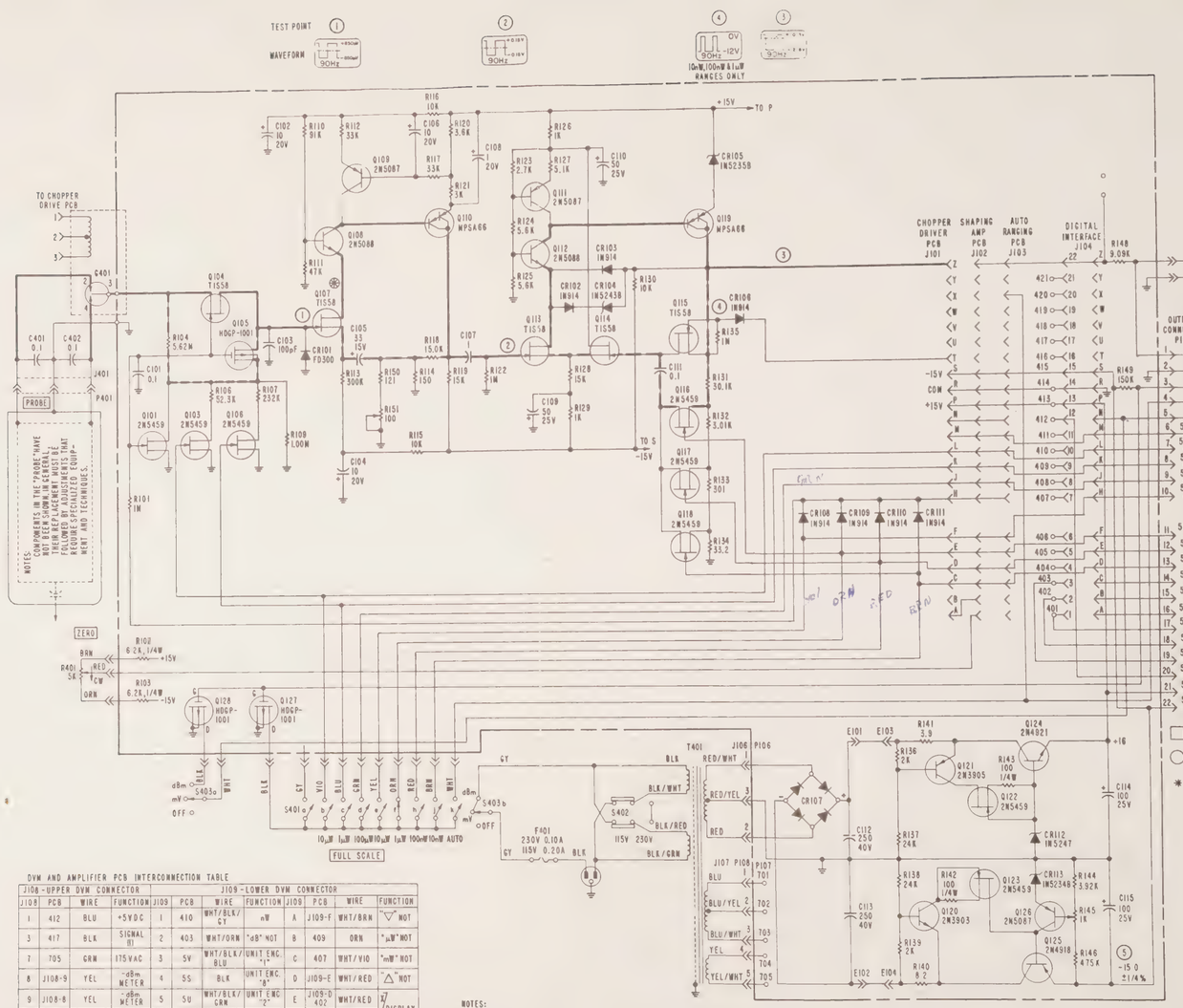


NOTES:

1. CAPACITANCE VALUES IN pF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS AND 1/2 WATT, UNLESS OTHERWISE SPECIFIED.
3. ✳ PRECISION RESISTORS.
4. ALL TRANSISTORS TO BE TYPE MPS6516, UNLESS OTHERWISE SPECIFIED.
5. ALL DIODES TO BE TYPE IN914, UNLESS OTHERWISE SPECIFIED.
6. ▭ EXTERNAL MARKINGS.
7. LAST NUMBERS USED: R757 C716 Q725 CR750
8. ON MODEL 42-3A(42AD-01) THIS VALUE IS 10.0K.
9. ON MODEL 42-3A(42AD-01) THIS VALUE IS 95.3K.
10. THIS CONNECTION FOR 42-3A(42AD-01).

BOONTON ELECTRONICS CORPORATION

MODEL 42AD
Schematic, Auto Range
830483C



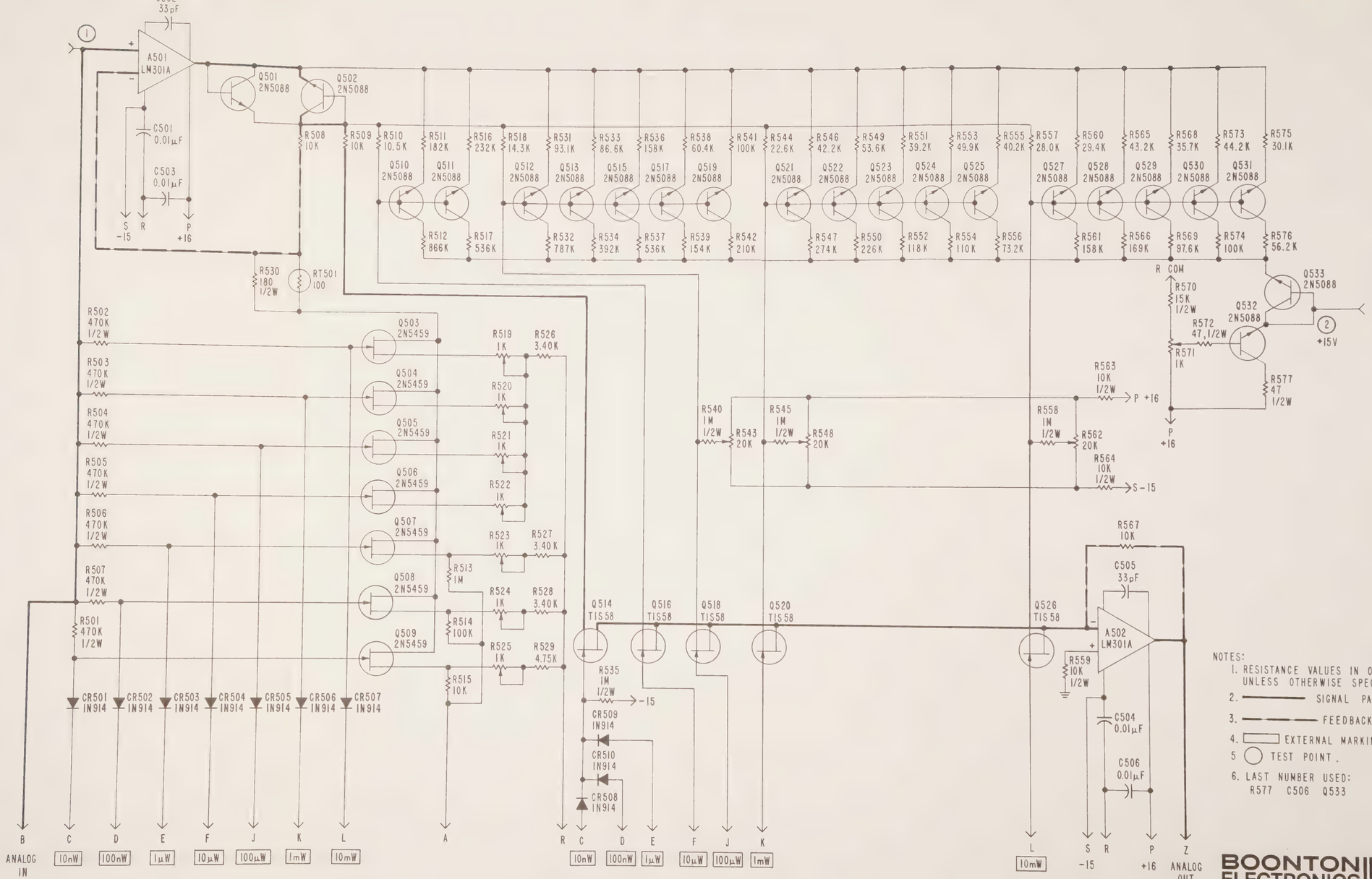
DVM AND AMPLIFIER PCB INTERCONNECTION TABLE

J108-UPPER DVM CONNECTOR				J109-LOWER DVM CONNECTOR							
J108	PCB	WIRE	FUNCTION	J109	PCB	WIRE	FUNCTION	J109	PCB	WIRE	FUNCTION
1	412	BLU	+5VDC	1	410	WHT/BLK/GY	mW	A	J109-F	WHT/BRN	▽ "NOT
3	417	BLK	SIGNAL (I)	2	403	WHT/ORN	"dB" NOT	B	409	ORN	"µW" NOT
7	705	GRN	175 VAC	3	5V	WHT/BLK/BLU	UNIT ENC. "1"	C	407	WHT/VIO	"mW" NOT
8	J108-9	YEL	-dBm METER	4	5S	BLK	UNIT ENC. "8"	D	J109-E	WHT/RED	"△" NOT
9	J108-8	YEL	-dBm METER	5	5U	WHT/BLK/GRN	UNIT ENC. "2"	E	J109-D 402	WHT/RED	X/Y DISPLAY
10	418	WHT/BLU/BLK	+dBm METER	6	5T	WHT/BLK/VIO	UNIT ENC. "4"	F	J109-A 401	WHT/BRN	-X-Y
A	704	YEL	175 VAC	7	5W	WHT/BLK/YEL	-dBm	H	5X	WHT/BLK/ORN	HOLD
D	J108-J 416	WHT	COMMON	8	408	WHT/GY	"W"	J	5Y	WHT	"I"
E	703	ORN	12.5 VAC	9	5R	BRN	TEN ENC "1"	K	414	WHT/BLK	COMMON
F	701	BRN	12.5 VAC	10	5M	YEL	TEN ENC "8"	L	5Z	WHT/BLK/BRN	TRIGGER
H	702	RED	12.5 VAC CT	11	5P	RED	TEN ENC "2"	M	5N	ORN	TEN ENC "4"
J	J108-D	WHT	SIGNAL LO	12	5L	BLU	HUND. ENC. "1"	N	5Y	WHT/BLK/RED	ENC. COMPL
K	413	VIO	+15VDC	13	5H	GY	HUND. ENC. "8"	P	404	WHT/YEL	UNIT DEC. POINT
L	415	GY	-15VDC	14	5K	GRN	HUND. ENC. "2"	R	405	WHT/BLU	TENS DEC. POINT
2,4,5			NC	15	5J	VIO	HUND. ENC. "4"	S	406	WHT/GRN	HUND. DEC. POINT
6,B,C			NC								

NOTES:
1. CAPACITANCE VALUES IN µF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS & 1/2 WATT, UNLESS OTHERWISE SPECIFIED. (EXCEPT R105-R109, R114, R118, R131-R134, R144, R146, R148 & R150 WHICH SHALL BE 3/8 WATT).
3. ⊛ FACTORY SELECTED VALUE.
4. ▭ EXTERNAL MARKINGS.
5. ——— SIGNAL PATH.
6. ——•——• FEEDBACK PATH.
7. ——•——• SIGNAL PATH FOR 100µW, 1mW, 10mW RANGES ONLY.
8. TEST CONDITIONS:
   1µW RANGE
   1µW SIGNAL
9. LAST NUMBERS USED:
   R151 C115
   R401 C402
10. NUMBERS NO. USED:
    R105, R108, R147, Q102

BOONTON ELECTRONICS CORPORATION

MODEL 42AD
Schematic, Amplifier
830491D (Sh 1 of 3)

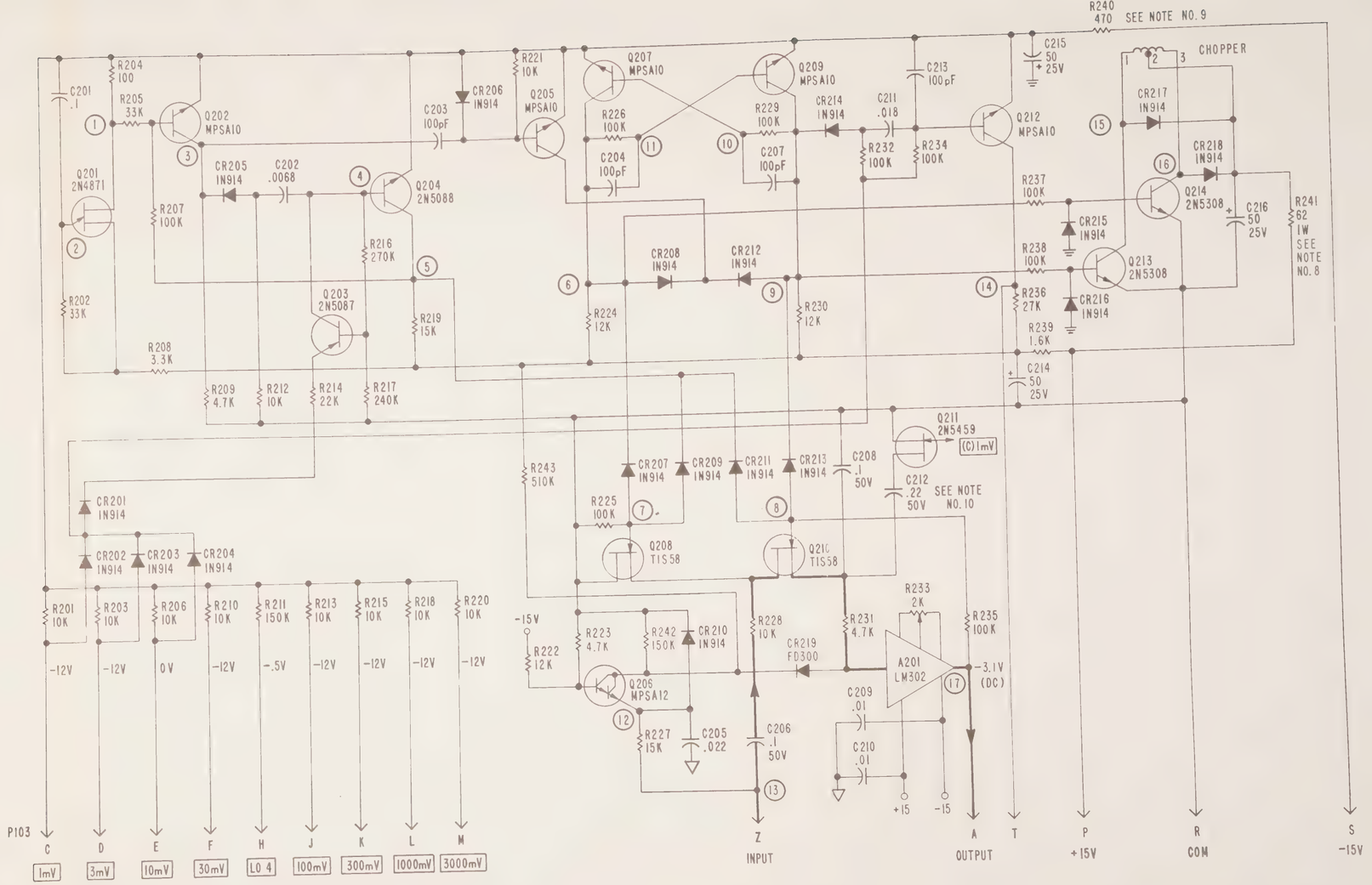


NOTES:

1. RESISTANCE VALUES IN OHMS AND 3/8 WATT, UNLESS OTHERWISE SPECIFIED.
2. ——— SIGNAL PATH.
3. — — — FEEDBACK PATH.
4. ▭ EXTERNAL MARKINGS
5. ○ TEST POINT.
6. LAST NUMBER USED:
   R577 C506 Q533

BOONTON ELECTRONICS CORPORATION

MODEL 42AD
Schematic, Shaping Amp.
830491B (Sh. 2 of 3)



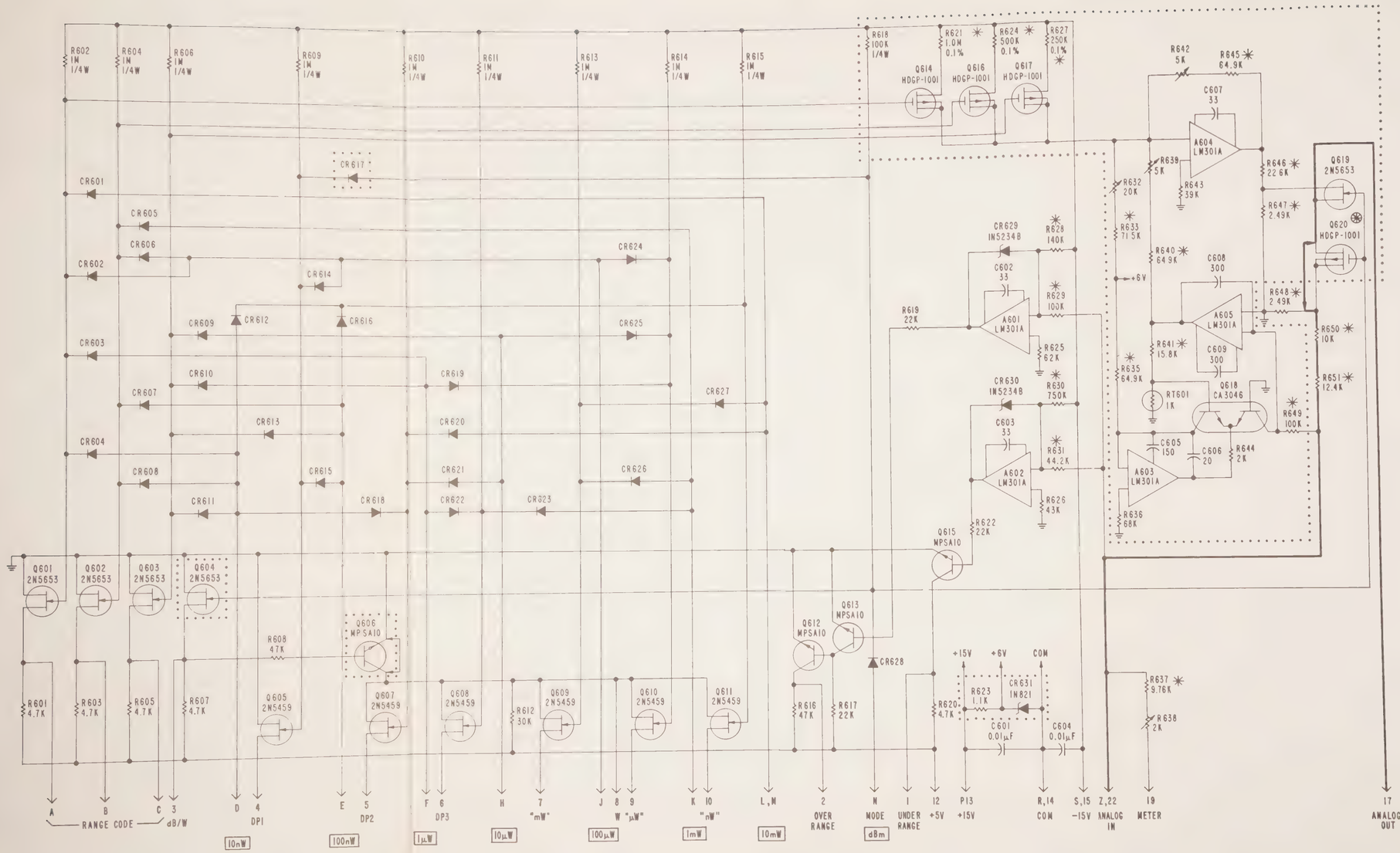
NOTES:

1. CAPACITANCE VALUES IN μF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS & 1/2 WATT, UNLESS OTHERWISE SPECIFIED.
3. ▭ EXTERNAL MARKINGS.
4. ▽ COMMON
5. ——— SIGNAL PATH
6. TEST CONDITIONS: 10mV RANGE 10mV SIGNAL
7. LAST NUMBERS USED: R242 C216 Q214 CR219
8. ON MODEL 92AB THIS VALUE IS 270Ω, 1/2W.
9. ON MODELS 92AD & 42AD THIS VALUE IS 300Ω, 1/2 WATT.
10. ON MODEL 92AD & 42AD THIS VALUE IS 0.47μF, 50V.

Board

BOONTON ELECTRONICS CORPORATION

MODEL 42AD
Schematic, Chopper Driver
830456J (Sh 2 of 3)



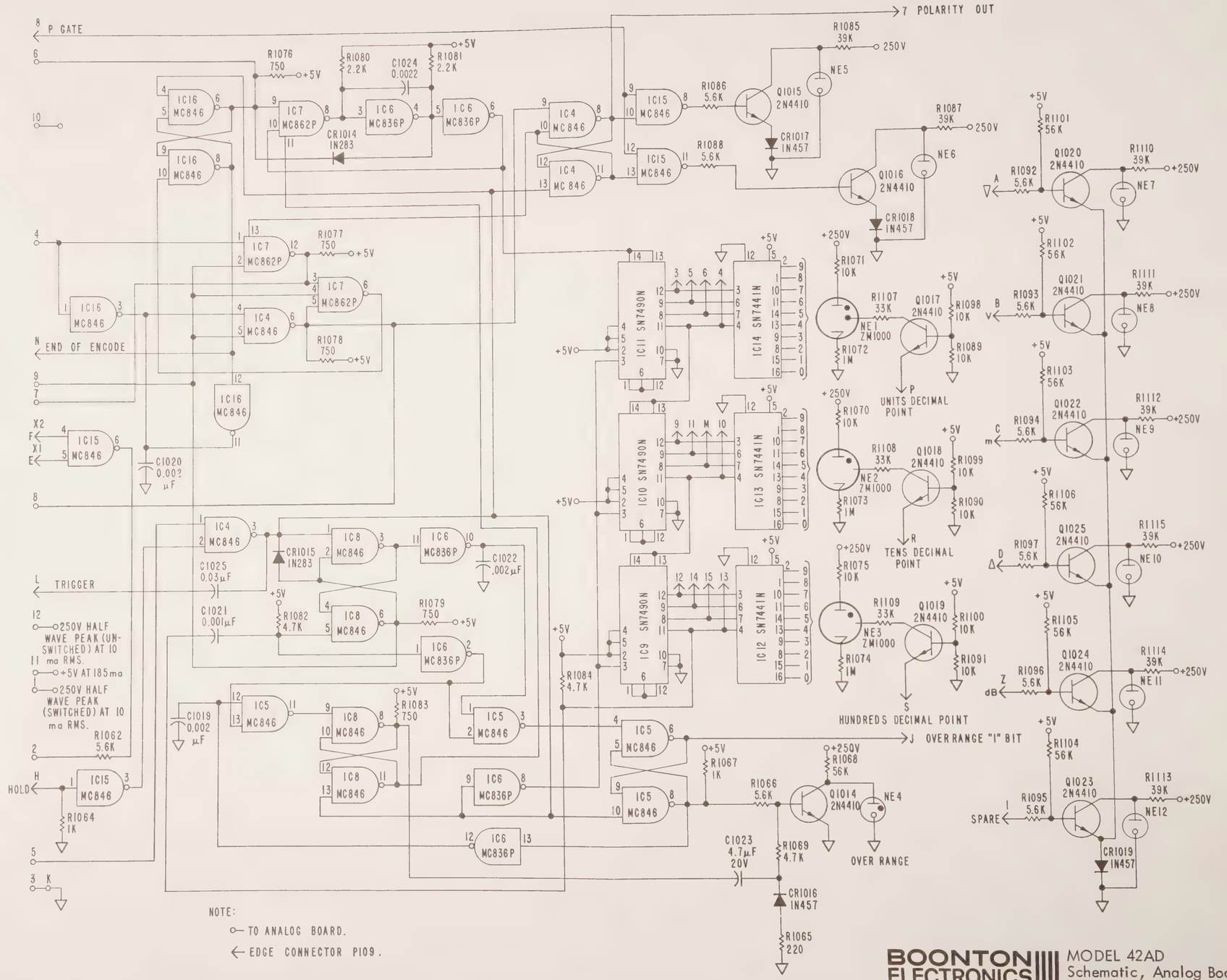
NOTES:

1. CAPACITANCE VALUES IN pF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS AND 1/2 WATT, UNLESS OTHERWISE SPECIFIED.
3. ⊛ FACTORY SELECTED VALUE.
4. ✳ PRECISION RESISTOR, 3/8 WATT.
5. ALL DIODES TO BE TYPE IN914, UNLESS OTHERWISE SPECIFIED.
6. ▪ ▪ ▪ SIGNIFIES COMPONENTS ADDED FOR 42-4A. ▪ ▪ ▪
7. ⌐ DENOTES JUMPER USED ON MODEL 42AD WITH NO dB OPTION.
8. ▭ EXTERNAL MARKINGS.
9. ——— SIGNAL PATH
10. LAST NUMBER USED: R651 C609 Q620
11. NUMBERS NOT USED: R634

P104

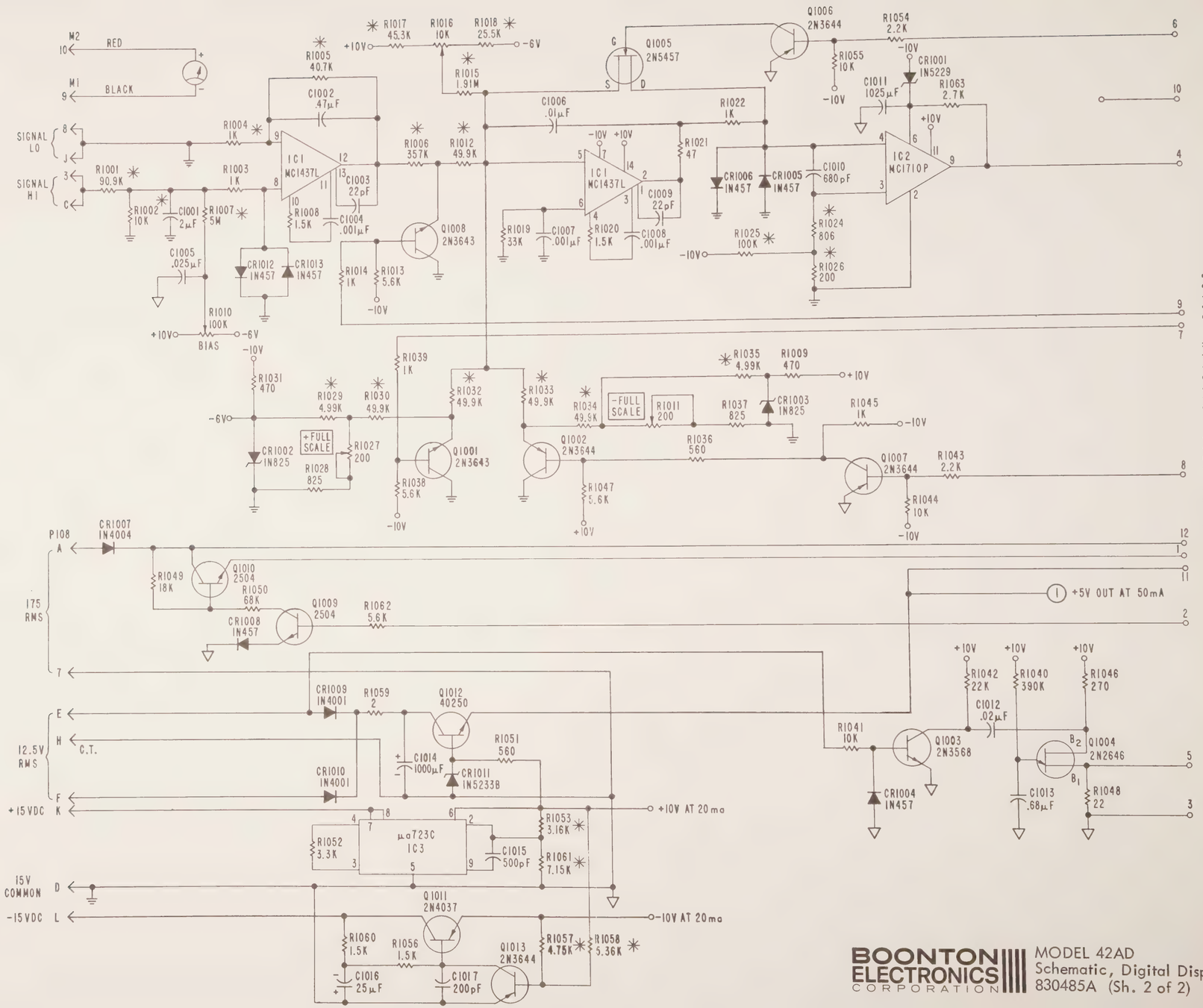
BOONTON ELECTRONICS CORPORATION

MODEL 42AD
Schematic, Digital Contro
830491C (Sh 3 of 3)



BOONTON ELECTRONICS CORPORATION

MODEL 42AD
Schematic, Analog Board
830485A (Sh. 2 of 2)



BOONTON ELECTRONICS CORPORATION

MODEL 42AD
Schematic, Digital Display
830485A (Sh. 2 of 2)

SCHEMATIC
LOGIC LEVEL PROGRAMMING CONVERTER
TTL/DTL COMPATIBLE
MODEL 92-2B

NOTES:

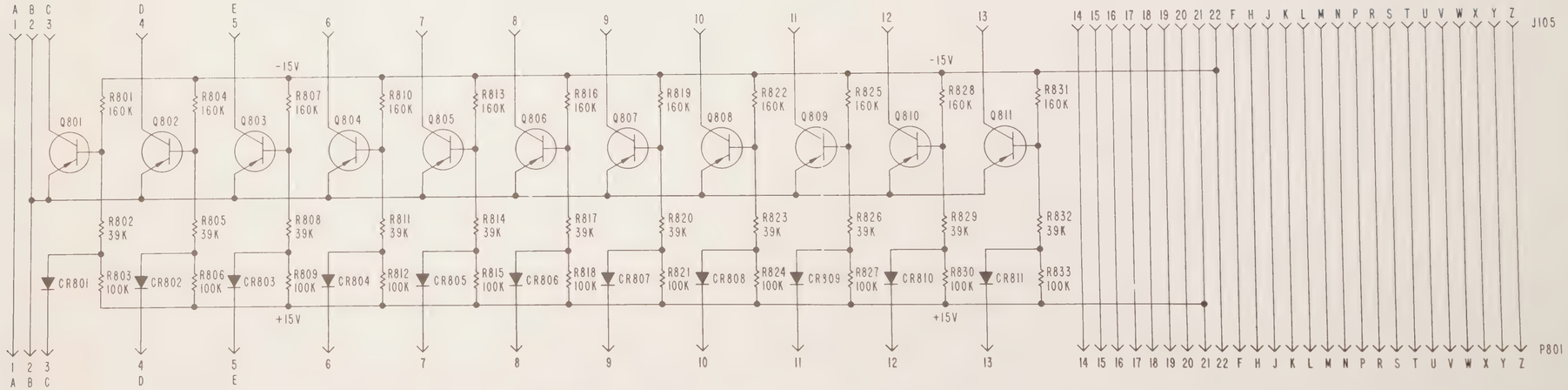
1. RESISTANCE VALUES IN OHMS AND 1/8 WATT, UNLESS OTHERWISE SPECIFIED.
2. ALL TRANSISTORS TO BE TYPE MPS 6516, UNLESS OTHERWISE SPECIFIED.
3. ALL DIODES TO BE TYPE IN4148, UNLESS OTHERWISE SPECIFIED.
4. LAST NUMBERS USED:
   R833 Q811 CR811

PIN ASSIGNMENTS

P801

	92	42		92	42
1	DC ANALOG		A	DC ANALOG	
2	COMMON		B	COMMON	
3	MANUAL DISABLE		C	MANUAL DISABLE	
4	AUTO ENABLE ⊛		D	AUTO ENABLE ⊛	
5	dBm ENABLE ⊛		E	dBm ENABLE ⊛	
6	3000mV	N.C	F	MSD 1 ⊛	
7	1000mV	+10dBm	H	8	
8	300mV	0 dBm	J	4 BCD ⊛	
9	100mV	-10 dBm	K	2	
10	30mV	-20 dBm	L	1 ENCODED	
11	10mV	-30dBm	M	8	
12	3 mV	-40dBm	N	4 DATA	
13	1 mV	-50dBm	P	2	
14	4		R	1	
15	2 RANGE CODE		S	8	
16	1		T	4 (LSD)	
17	UNDER RANGE ⊛		U	2	
18	OVER RANGE ⊛		V	1	
19	mV MODE	µW MODE	W	+dBm ⊛	
20	+5V DC		X	HOLD	
21	+15V DC		Y	COMPLETE ENCODE	
22	-15V DC		Z	TRIGGER	

⊛ DIGITAL VERSIONS ONLY



PROGRAMMING INPUT

BOONTON ELECTRONICS CORPORATION
MODEL 42AD
Schematic, Logic Level
830490A

Warranty

Boonton Electronics Corporation warrants its products to the original Purchaser to be free from defects in material and workmanship and to operate within applicable specifications for a period of one year from date of shipment, provided they are used under normal operating conditions. This warranty does not apply to vacuum tubes that have given normal service, to sealed assemblies which have been opened, or to any item which has been repaired or altered without our authorization.

We will repair or, at our option, replace at no charge any of our products which are found to be defective under the terms of this warranty. Except for such repair or replacement, we will not be liable for any incidental damages or for any consequential damages, as those terms are defined in Section 2-715 of the Uniform Commercial Code, in connection with products covered by this warranty.

BOONTON ELECTRONICS CORPORATION

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MP MASTER
MA24767